AVIATION
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World Airways, 1934

A survey of international airlines, their commercial and political significance, their aspirations and their governmental relationships

By Daniel Sayre

THERE is a tendency in this country to evaluate and discuss air transport almost entirely in terms of our own domestic airlines, to consider it as an extra and optional service superimposed upon an already excellent and efficient system of communications. The average American seldom visualizes the mere availability of an airline having an important effect upon the volume of business his firm would do in this or that particular part of the country.

Two general classes of persons would disagree heartily with such a point of view. One, all those Americans who deviate sufficiently from the average as to have business relations with South America. Two, the citizens of almost every other civilized nation on the globe. For once beyond the customs barriers of these states, the domain of air-transport-the-convenience ceases and that of air-transport-the-necessity begins. And it is with such a fundamental conception of an air route as a trade route, as a channel along which flow commercial, social, and political relationships as they could not possibly flow by any other existing means, that we must approach the past record and future possibilities of long range international and intercontinental airlines.

It is no new conception. It was expressed in a half dozen European languages during the months immediately following the World War. Against the background of a communications system disrupted and partially destroyed by four years of conflict, the long range possibilities of the new transport form appeared immediately attractive. Within a few months of the first beginnings of the trans-channel and the intercapital routes which were to spread over the map of Europe, France had extended a line from Paris to Bucharest and had established air connections with its colonies in Northern Africa. By the end of 1921 German and Russian interests had set up the Deruluft services between Berlin and Moscow. Along these early routes traveled government officials, important mails, and commercial prestige at a time when nothing seemed so important as the establishment of new economic and political relationships and the restoration of old ones.

Before 1928

By the time the Pan American Airways was cutting its teeth on its original contract to expedite first-class mail from Key West to Havana in 1928, a British company was flying mail from Cairo to Basra, a French line was delivering mail in Buenos Aires nine days from Europe, German lines were operating in two parts of South America and in Persia, and the Belgians had opened up their Congo colony by seaplane as it had never been opened before. By that time, too, most of the elements which now seem indispensable to the world route technique had already emerged. Practical subsidy policies had been evolved and through them all the important aeronautical powers save France had brought about mergers of their international operating companies into single efficient units, and even France has restricted her four or five companies to non-competing spheres of development. The general feud between the Allied and Central powers had been abated following the removal of restrictions on the design features of German aircraft and the promulgation of many bilateral agreements for mutual air transport operations.

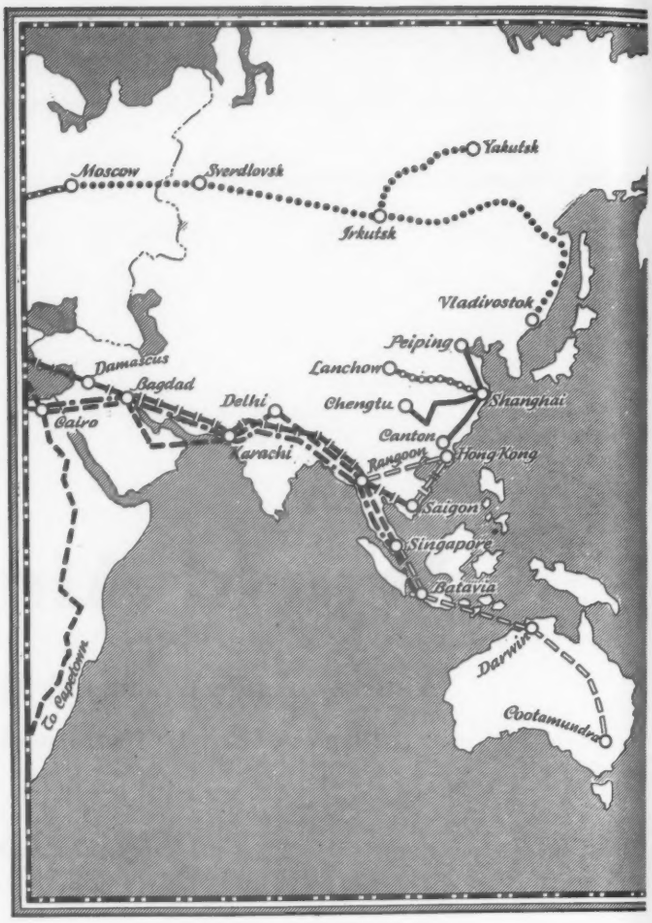
Subject to occasional disputes over traffic division, and the complication of colonial policies, the various European interests had learned to compete in peace. On the shorter intercapital lines, already dwindling in importance, alternate services by planes of the two nationalities involved has in fact become the rule rather than the exception. On the longer lines as it became obvious that there would be competing efforts to reach Asia and South America the progress of agreement was slower but not too often hopeless. With so much at stake mutual obstruction has always proved ultimately unprofitable.

One other thing was likewise generally recognized; air transport was fac-

ing no easy task from the purely physical point of view. To go where existing transport was slow and unsatisfactory was to go where climate and terrain had ever been considered unfavorable to land transport, or to bridge wide stretches of ocean where only the steamer could compete. The route from Europe to Southern Asia requires the crossing of a mountain range, the traversing of the Mediterranean, a terrific encounter with the heat of the Arabian desert and the tropical jungle, and storm conditions of parts of India and the Malay Peninsula. The route from Cairo to Cape Town traverses desert, mountain and equatorial wilderness. The French line to South America passes over territory still full of hostile tribesmen who enjoy nothing so much as the extermination or kidnaping of an airplane crew. The Pan American routes pass through Mexico with its fogs and mountains, the Caribbean with its hurricanes, and South America with its river harbors, its jungles and its Andes. And in such ungentle places operations must be carried on without benefit of improved airports, radio, meteorological facilities or beacon lights, without even good land transport in case of trouble, except as all these things may be slowly created by the airline operators themselves. No wonder night flying on international routes is still almost unheard of. No wonder that from the "laboratory of experience" set up by such severe conditions has come the development of so much excellent equipment and operating technique.

The progress during the last five years has been tremendous. The development of the magnificent Pan American Systems, the services pioneered across the South Atlantic, by the French and Germans, the completion of the Imperial airways extensions to Africa and Singapore, and the opening of the Dutch lines to Batavia and the French lines to Saigon would be enough to assure the fame of any aeronautical epoch had not a single propeller turned elsewhere. Nor is the progress recognized by the aeronautical profession alone. From every trunk line on the globe comes report of greatly increased traffic records; a doubled service made necessary in Africa; a 100 per cent increase in KLM passenger traffic to Batavia; a steady increase of Pan American passenger and mail loads and a phenomenal growth of its express poundage.

The prospects for the future, and the not too distant future at that, are colossal. Pan American is placing its new huge Sikorskys and a number of the new high speed Douglas transports into service on its already existing schedules. Its flight technique and personnel are fully ready for the North Atlantic operation via Bermuda and the Azores. In Alaska and China it has laid the foundation of a northern route from the United States throughout Asia. From Southern Asia three nations are ready to complete the skein of routes binding Europe with Africa, Eastern Asia and Australia. A single additional season should see the South Atlantic fully conquered. Three years, five years until the basic network is completed—another five until it will be operated at speeds and on schedules comparable with our domestic lines, who can tell? There are a hundred possible permutations and combinations of political and economic factors alone which remove the problem from the purely technical, and render it infinitely complex and extremely unpredictable.

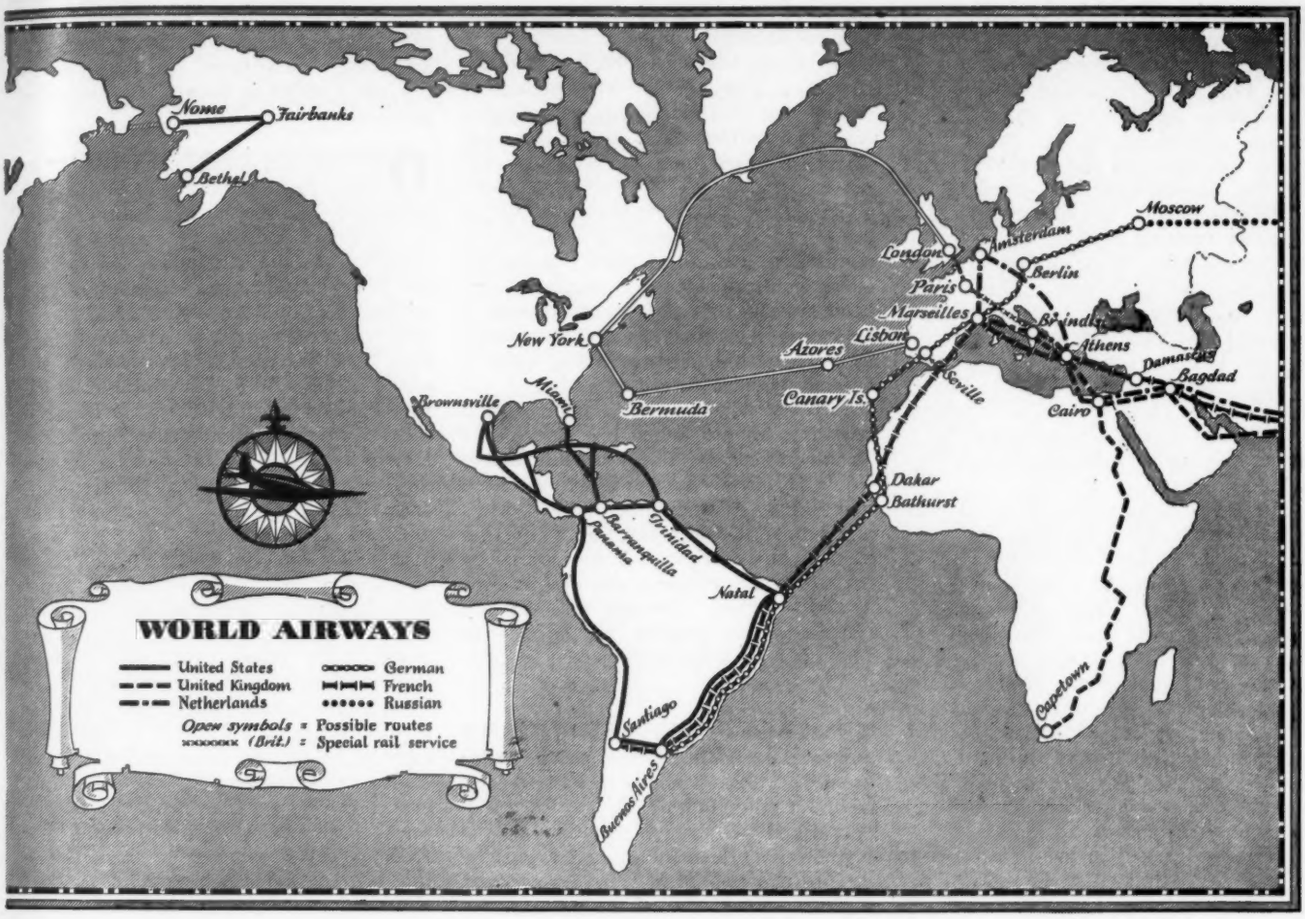


Meanwhile one thing is certain. The American aeronautical industry is in for an increasing pressure toward wider concepts of its destiny, broader demands for a knowledge and understanding of operating conditions as they exist outside our borders, and an appreciation of the competitive potentialities of nations as presently remote as the Netherlands and the Australias. AVIATION takes this opportunity to present a brief summary of the background, status, and discernible plans of those companies most likely to share prominently in coming events.

PAN AMERICAN AIRWAYS began its operations on Oct. 27, 1927, carrying mail from Key West to Havana. The project of an airline network speeding trade relations between this country and Latin America was not new; the Key West–Havana, first step had been opened in 1919 and operated with some success for several years thereafter and isolated pioneers had barnstormed throughout the islands of the Caribbean and the countries of Central America intermittently since the Armistice. In some instances temporary "line services" had actually been set up. It remained for that union of interests known as the Aviation Corporation of the Americas, holding company for Pan American Airways, to first bring together prestige and resources sufficient to match the magnitude of the undertaking.

The next three years of the company's history constitute one of the most remarkable records of expansion ever established in any field of transportation. Significant factors were the early participation in its ownership by almost every important aeronautical and holding group of the country without dominance by any, and the adoption of a financial policy ruling out heavy promotional fees and returning to the business whatever profits might accrue during a lengthy period of expansion and consolidation. Not until this year came the declaration of the first dividend, 25 cents on each of its 631,640 shares. Total assets as of Dec. 31, 1933, were $23,250,000.

Important milestones in the expansion were the formation in 1929 of Pan American Grace Airways to operate on the west coast of South America, evenly divided in ownership between the Aviation Corporation of the Americas and the Grace Line, and the absorption in 1930 of NYRBA, operating on the east coast and across the Andes. In 1929 came changes of the basic air mail laws of this country permitting the Post Office to issue two-way contracts on international routes, to make special charges for foreign airmail service, and to allow its



contract holders to negotiate with other governments for additional mail traffic along the routes.

From its contracts with the Post Office, most of which run until 1939, the Pan American Airways System receives approximately $6,800,000 annually. To attempt to evaluate the service in terms of increased trade and good will between this country and Latin America would be beyond the scope of this summary; the best index is perhaps the increasing use made of it. In 1933, in the face of a 30 per cent drop in surface mail volume, air mail volume over the lines increased 18 per cent over that in 1932. Passenger mileage has climbed steadily until last year it exceeded 24,000,000, 40 per cent over 1932. Express service, started in 1931 and within the last month greatly simplified and expedited, increased 80 per cent between 1932 and 1933. Unlike the situation of almost all other world air route companies, which receive beside their basic operating subsidy whatever postage is charged for the mails of the home country that they carry, the contracts between Pan American Airways and the Post Office call for the retention of these postal charges by the government. In 1933 this amounted to $1,867,000.

Although its basic route map in Latin America had reached very approximately its present form by the fall of 1930, many minor modifications and extensions have taken place from time to time, especially in the Caribbean and Western Divisions. Services have also been generally speeded and increased in frequency. In 1931 the company flew 4,075,500 miles, in 1933, 5,389,500 on its lines in Latin America.

The present Pan American fleet in Latin America consists of 101 planes, including many Ford trimotors and a flotilla of Sikorskys of practically every model from the S38A to the 38-passenger clippers specially designed and constructed in 1931 for the Caribbean service. Eight Consolidated Commodore flying boats were secured from NYRBA and have since been consistently in use. Additions in the near future will include a number of small high speed Fairchild amphibions and the giant Sikorsky S-42. During the fall a number of Douglas and Electra Transports will be put in service. Still building are three giant seaplanes at the Martin factory near Baltimore, and two more S-42's.

Pan American's achievements in the south have been brilliant enough to have satisfied almost any other group of men except the very one which conceived and executed them. From the very outset, however, there have been unmistakable indications that the company held truly world wide ambitions. It has carried on conferences since 1928 with all the important airline companies of Europe and Imperial Airways in particular in relation to the crossing of the North Atlantic with scheduled airplane service. From TransAmerican Airways it acquired interests in the north and subsequently sole rights across Iceland and permission from Denmark to establish meteorological surveys in Greenland. It has reached workable understandings with the governments of Newfoundland and the Bermudas. Its use of the Azores has been made possible by the withdrawal of the French from their exclusive rights there. It has been carrying on a conscious development of personnel, aircraft and equipment for a Trans-Atlantic service for several years, culminating in the launching of the new S42. With the addition of a single ingredient, a mail contract, it is ready to start operating at least one route on a few months' notice.

Toward Asia it has been no less active. In the summer of 1932 it absorbed the airline activities of the Alaskan Airways and the Pacific International Airways. In 1933 it entered the direct Asiatic picture when it acquired a 45 per cent interest in the Chinese National Aviation Corporation. With these two nuclei extension possibilities are infinite; a connection between the two via Siberia or Japan; a line to the Philippines; a connection at Hongkong with the European lines across India; further extensions into China. The Asiatic route via Hawaii is also under survey.

IMPERIAL AIRWAYS, formed from four companies operating trans-Channel services, began operations in May, 1924. Its original agreement with the British Government called for a subsidy monopoly on any routes between England and the Continent, and for the payment to the company of £1,000,000 over a ten-year period at a definitely tapering annual rate, based on the performance of a million airplane miles of flying each year. This agreement has been greatly extended and several times modified as the Airways opened additional services: Cairo-Basra (1926), London-Cairo (1929), Basra-Karachi (1929), Cairo-Capetown (1932), and Karachi-Singapore (1933). It was originally capitalized for £1,000,000.

The Air Estimates for the fiscal year 1933-1934 provided £548,000 for payments to the line, of which £146,000 is recoverable from the Union of South Africa and other African administrations. The present basic agreement extends to 1939 and retains a provision for the repayment of the subsidy to the government out of profits in excess of 10 per cent on its capitalization. Its earnings from passengers and mail (not counted in subsidy) are considerable, subsidy representing about 45 per cent of its total income in 1933.

Although backed to the fullest extent by the Air Ministry and designed almost entirely to be a promoter of closer relations throughout the British Empire, Imperial Airways has trodden no rose-strewn path in the extension of its routes. Subsidy aid from the Union of South Africa was obtained only after long drawn out negotiations. The Indian Government has not only refused to grant a subsidy, but has required that operations through India be carried on by a company owned 51 per cent by Imperial Airways, 25 per cent by India National Airways, and 24 per cent by the Government of India.

Best-known non-British obstacles have been Persia, whose attitude has required the detouring of the line to India around the Persian Gulf, and Italy, with whom it has been difficult to agree on the terms of operating across its territory. Partly due to this latter situation, partly due to troubles encountered in its early Mediterranean seaplane operations, the route from London to Cairo has been several times shifted, at one time running through Germany and the Balkans to approach Athens from the north. The present service breaks the plane journey with a transfer to train from Paris to Brindisi.

Faced with a wide range of climatic conditions and the necessity of using poorly developed fields between Cairo and Singapore and Cairo and Capetown, the British school of airplane designers have been limited to the development of slow landing, moderate performance types, such as the Handley Page Heracles (London-Paris) and Hannibals (Cairo-Karachi), and the four-engined Short flying boats used on the Mediterranean. The recent introduction of Armstrong-Whitworth Atalantas in India and Africa has raised cruising speeds on these sections to about 135 m.p.h.

The extension of the line from Singapore to Cootamundra, Australia, planned for the fall of 1934, will be subsidized entirely by the Australian Government, and operated by an Australian company, Quantas Empire Airways, Ltd. A Rangoon-Hong Kong spur is another obvious future extension.

Imperial Airways, like Pan American Airways, shows increasing interest in an airline across the North Atlantic. To Imperial Airways this will be more than simply another link in the world's air routes; it will mean the completion of the plan of Empire communications for which the company was created, for after Australia, Canada will be the last important member of the British Commonwealth to be connected to London by air.

ROYAL DUTCH AIRLINES (KLM) entered the world route arena in 1928 when it began experimental flights linking up its European operations with the services in the Netherlands East Indies maintained by its subsidiary KNILM. Its Amsterdam-Batavia route differs from those of the English and French services to the Orient in that it includes no seaplane sections, approach to Cairo being via Central Europe in summer, via Marseille, Rome, and Athens in winter.

Delayed in establishing a permanent scheduled service by long negotiations with the Indian Government, it opened its present operations with a semi-weekly service in September, 1930. By 1933 it had increased its schedule to once a week and dropped its passenger tariff from $1,200 to $700.

Most "American" in policy of all European airlines, it has been bending every effort to cut its schedules. The Fokker XX, the Fokker XXXVI, and the Pander Postjager, all equipped with Pratt & Whitney or Wright engines, have been specifically designed for this purpose. The Postjager, with three Whirlwinds, has made the 8,400-mile run in 46 hours' flying time. The most recent addition has been a Douglas Transport.

Wide and aggressive publicity has enabled the line to increase its traffic greatly during the past year. The subsidy to KLM from the Netherlands Government is about $400,000 annually; its subsidiary KNILM receives about the same amount from the government of the East Indies.

Excellent relations are maintained along the Asiatic route with Air France and Imperial Airways. Monthly conferences are held. Rates have been equalized, the freight rate being 1/200 that charged for a passenger for each kilogram. Schedules are adjusted to prevent conflicting departures whenever possible.

DEUTSCHE LUFT HANSA is in many respects unique among European airlines, for the provisions of the Versailles Treaty have influenced its career from the beginning. Although the treaty handicapped Germany's early commercial aviation, this was the sole form of aeronautical activity permitted her. She has no colonies to which she can aim her lines, or through which she can gain access to commercial spheres beyond. As a consequence, Luft Hansa has made the most of its domestic opportunities and in offering co-operative services to the capitals of neighboring countries.

Of chief interest from the standpoint of world routes are the lines to Moscow and Leningrad operated by Deruluft, whose ownership is divided equally between Luft Hansa and the Russian Government, and the seaplane service it is developing to South America. The former company, organized in 1921 during the heyday of German-Russian co-operation, started a Koenigsberg-Moscow service to which were added the lines Koenigsberg-Berlin in 1925 and Koenigsberg-Leningrad in 1928. The line is remarkable not only for its dual ownership, but also for the fact that it received subsidies from both the German and Russian Governments.

Luft Hansa's interest in an airline to South America is by no means recent, for as early as 1928 trial flights were made to Africa looking toward a link across the South Atlantic with the lines of the Condor Syndicate, a Brazilian company closely allied with Luft Hansa and other German commercial interests. For a period in 1930 a service similar to that of Aeropostale was operated. The mails were flown from Germany to the Canary Islands, transferred to the regular steamers of the Hamburg-America Line, and then picked up by planes of the Condor Syndicate at Fernando de Noronha off the Brazilian coast. This was continued in 1931, supplemented by the Graf Zeppelin's six round trips between Germany and Brazil.

In 1932 preparations were begun for an all-air South American service. Luft Hansa converted the freighter Westfalen into a seaplane mother ship, and during 1933 its catapult and landing apron were tested in the Baltic Sea. The Dornier company produced a special model of the Wal for the route. Late in 1933 the Westfalen was stationed half way between Africa and Brazil, and a total of sixteen flights were made between the two continents. By using the new high performance Heinkel and Junkers monoplanes on the Africa-Germany section, it was demon-

strated that a six to seven-day service could be maintained between Buenos Aires and Berlin. On one occasion the mail reached Berlin less than three days after leaving Brazil.

A second mothership is now being equipped, and present plans call for the establishment of regular service during this summer. The seaplane trip will be made on alternate weeks; on the others the mail will be carried as far as Brazil by the Graf Zeppelin, thence by the Condor Syndicate to Buenos Aires. Pleased by the prospect of rapid regular air mail across the Atlantic, the Argentine Government recently granted the line a contract to carry mails to Uruguay, Brazil, Africa, and Europe.

On the other side of the world, where Luft Hansa owns a third of Eurasian Aviation Corporation with the Chinese Government as partner, all has not gone so smoothly. As early as 1926 Luft Hansa planes had flown through the U.S.S.R. to China, exploring a path to the Orient for Germany, but the confusion of political interests along the route has constantly nullified all efforts to establish the line. After Russia refused permission to fly over Siberia, a line was begun connecting the chief Chinese cities by air with the Trans-Siberian Railway at Manchouli. When this route was closed by the Sino-Japanese struggle in Manchuria, a start was made in another direction, this time to Urumchi in Chinese Turkestan, from which it was hoped a connection could be established to a Russian airline at Semipalatinsk. Now the line to Urumchi has been interrupted by the turmoil in Chinese Turkestan, and the Eurasian Aviation Corporation has to content itself with the operation of several domestic lines within China.

The amount of subsidy received by Luft Hansa has always been difficult to determine as, in addition to the subsidy from the Federal Government, it receives grants from the various German states and communities it serves totaling in recent years about a third the amount of the federal subsidy. Luft Hansa received 17,362,000 marks from the Federal Government in the fiscal year 1932-1933; for 1933-1934 the subsidy is not definitely known, but total appropriations for civil aviation have almost doubled, the explanation given being that heavy replacement of obsolescent aircraft, particularly by multi-motored types, was imperative.

AIR FRANCE, most recently established of world route operators, resulted from a merger of all French airline activities effected during the summer of 1933. Its 1934 subsidy is 150,000,000 francs, a reduction of about 40,000,000 francs from those of recent years. Its agreement with the French Government calls for an annual decrease of 5,000,000 francs until 1937, after which 135,000,000 will be paid each year until 1943. Toward repayment, after 1936 the French Government is to receive half the excess of commercial receipts over those of 1933.

The four companies taking part in the merger were the Air Union, Air Orient, International Air Navigation Company (Cidna), and General Air Transport Company. Aeropostale, still undergoing liquidation, was not included, but its facilities are being operated by Air France under lease. The new company is capitalized at 120,000,000 francs, a third of which is held by the government.

In addition to many short European and trans-Mediterranean services Air France operates the important world routes Marseille-Saigon, opened in 1931 by Air Orient; the Toulouse-Santiago service across the South Atlantic begun by Aeropostale in 1927-1928; and the venerable Paris-Bucharest-Istanbul service dating back to 1920.

Since the settlement of its early feuds with Germany, which were common before the lifting of the limitations on German commercial aircraft, France's chief difficulties in expansion have come from changes in its own policy and general economic situation rather than from colonial or foreign obstruction.

The general French policy of developing a wide variety of aircraft types has resulted in extremely variegated equipment on the European and Asiatic runs. Recently attempts have been made to improve the latter service by the development of a high-speed land plane transport, the Dewotine D-332 (see AVIATION, November, 1933) among others being specifically designed to meet the competition of the KLM.

To Aeropostale must go the credit for pioneering the route along the east coast of South America and for early Andean crossings. The company began its first service from France to Africa in 1919, and by 1925 had extended its line down the African coast to Dakar. In 1927 the line from Natal, Brazil, to Buenos Aires was opened, and in the next spring the route was completed by dispatching the mails between Dakar and Natal in patrol boats hired from the French Navy.

In the next few years a number of extensions were made in South America, and the time was reduced to nine days by the introduction of night flying. During 1929 extensions branched out from Buenos Aires to Asuncion, Paraguay; Santiago, Chile; and Comodoro Rivadavia in Patagonia. In 1930 a 700-mile line was opened in Venezuela, and the length of the Patagonian extension was increased to 1,650 miles. During this period and in spite of a large subsidy the company's heavy losses forced constant borrowing and continual increases in its capitalization.

In 1931 its financial troubles began, politico-financial scandal broke out, and the extensions were abandoned one after another until only the main trunk from Natal to Santiago remains. Faced with the threat of German competition, and with cancellation of franchises dependent on replacement of the dispatch boats by an air service, France has for several years been striving to develop a suitable flying boat for that part of the route, and also has experimented with landplanes for the crossing. The most recent flights have been made with the three-engined Couzinet landplane Arc-en-Ciel, piloted by Mermoz. During the winter the Latecoere 300 flying boat Southern Cross also flew to Brazil and return, setting a straight line seaplane distance record of 2,670 miles.

More discouraging have been the loss of exclusive rights to operate in the Azores, due to failure to continue annual payments of 200,000 francs to Portugal; the failure to secure appropriations for the long-discussed service to Madagascar in conjunction with the Belgian Sabena operating in the Congo; and the inability to date of reaching a traffic pool agreement with Luft Hansa for the South Atlantic, due fundamentally to the Franco-German tension in Europe. The near future will probably see an extension of the Oriental line from Saigon to Hanoi, and from there to Southern China and Hongkong.

Tabular view of principal world routes

	Length	Frequency
Pan American Airways		
Miami-Buenos Aires (east coast)	7399	W
Miami-Montevideo (west coast)	6354	BW
Brownsville-Canal Zone	2365	BW
Air France		
Toulouse-Dakar	2920	W
Dakar-Natal (by steamer)	1900	W
Natal-Santiago	3265	W
Toulouse-Santiago	8085	W
Paris-Saigon	8370	W
Paris-Istambul	1680	BW
Luft-Hansa-Condor		
Berlin-Bathurst	3300	SW
Bathurst-Natal	1850	SW
Natal-Buenos Aires	2925	SW
Berlin-Buenos Aires	8075	SW
Berlin-Moscow	1040	D
Imperial Airways		
London-Cairo	2426*	BW
Cairo-Capetown	5537	W
London-Capetown	7963	W
Cairo-Singapore	5915	W
London-Singapore	8341	W
Royal Dutch Airlines (KLM)		
Amsterdam-Batavia (winter)	8691	W
Amsterdam-Batavia (summer)	8417	W

*Of this, 1147 miles by train—Paris-Brindisi.
W—Weekly. BW—Bi-weekly. SW—Semi-weekly. D—Daily

Northwest Passage

Progress report on Pan-American's Arctic flight laboratory

AS INDICATED elsewhere in this issue, the Caribbean Division of Pan-American Airways evolved by natural processes into a training ground for future trans-Atlantic operations. The Pacific Alaska Airways (the operating subsidiary of Pan American Airways) on the other hand, was considered as an experimental operation from its earliest inception. Beyond offering an opportunity to provide fast transportation in a country where other forms were far from adequate it occupies a strategic position in the trans-Pacific air route picture, for the distance between Seattle and Shanghai by way of Alaska is substantially shorter than that between San Francisco and Shanghai via the Hawaiian Islands. Once it was demonstrated that it is feasible to carry on year-round airline operations in Alaska, the key to the larger Pacific problems was in hand. Furthermore, the lessons learned from sub-Arctic operations may be applied directly to certain problems to be met in the trans-Atlantic crossings by the Northern route.

Transport operations in Alaska resemble little else in the world. On one hand, flying is relatively difficult due to terrain, vagaries of Arctic weather, and lack of the airway and terminal facilities that are considered *sine qua non* here in the States. In the central portion in which, except for short lines jutting north above the Arctic Circle to Wiseman and Fort Yukon, principal operations have been confined, temperatures range from 90 deg. above zero in the summertime to 65 or 70 deg. below in the winter. Summer rainfall is moderate and the winter snowfall is usually not excessive, but when snow does fall, it stays for months in hard, dry, wind-driven grains. On the other side of the picture, land transportation is so notoriously bad, except for the short trip from Seward to Fairbanks, served by the Territory's single standard gage railroad, that competition is not at all serious. In the brief summer season, steamers churn their way slowly up and down the winding rivers. In the long winters, dog-teams average their 20 miles a day over the frozen surfaces of the same circuitous routes. During transition seasons, spring and fall, overland and water transport breaks down altogether for weeks at a time, while rivers thaw or freeze solid. Against such competition air transport may easily score brilliant triumphs. Contrast for example, the five to six-hour flights between Nome and Fairbanks with the four to six weeks trip by dog-sled between the same points.

Mail contracts

As in other parts of the world mail contracts play an important part in air transportation development in Alaska. Pacific Alaskan inherited from Alaskan Airways and Pacific International about a dozen existing contracts, but they were contracts unlike those held by operators in the States. They are not air mail contracts at all, but Star Route contracts, designed for dog-team operation and simply turned over to airplanes. They were effective only in the winter (Sept. 1 to May 15), for during the summer months mail in Alaska is carried by government steamships. They required the transportation of 800-1,200 lb. of mail of all classes and specified frequent stops not only at local post offices, but also at the homes of addressees along the route. Theoretically, at least, any Sourdough in his shack in the hills could expect to have his annual Sears & Roebuck catalog delivered by airplane directly to his front door. Practically, it has required the airway to contract with dog team owners to render extensive supplemental services. Routes were scattered hit or miss, without any continuity. On top of it all the contracts did not pay any too well for 100 per cent performance, and extracted substantial forfeits for failure to perform. In other words, they would be difficult to operate over the prairies of Kansas, —and interior Alaska is no Kansas.

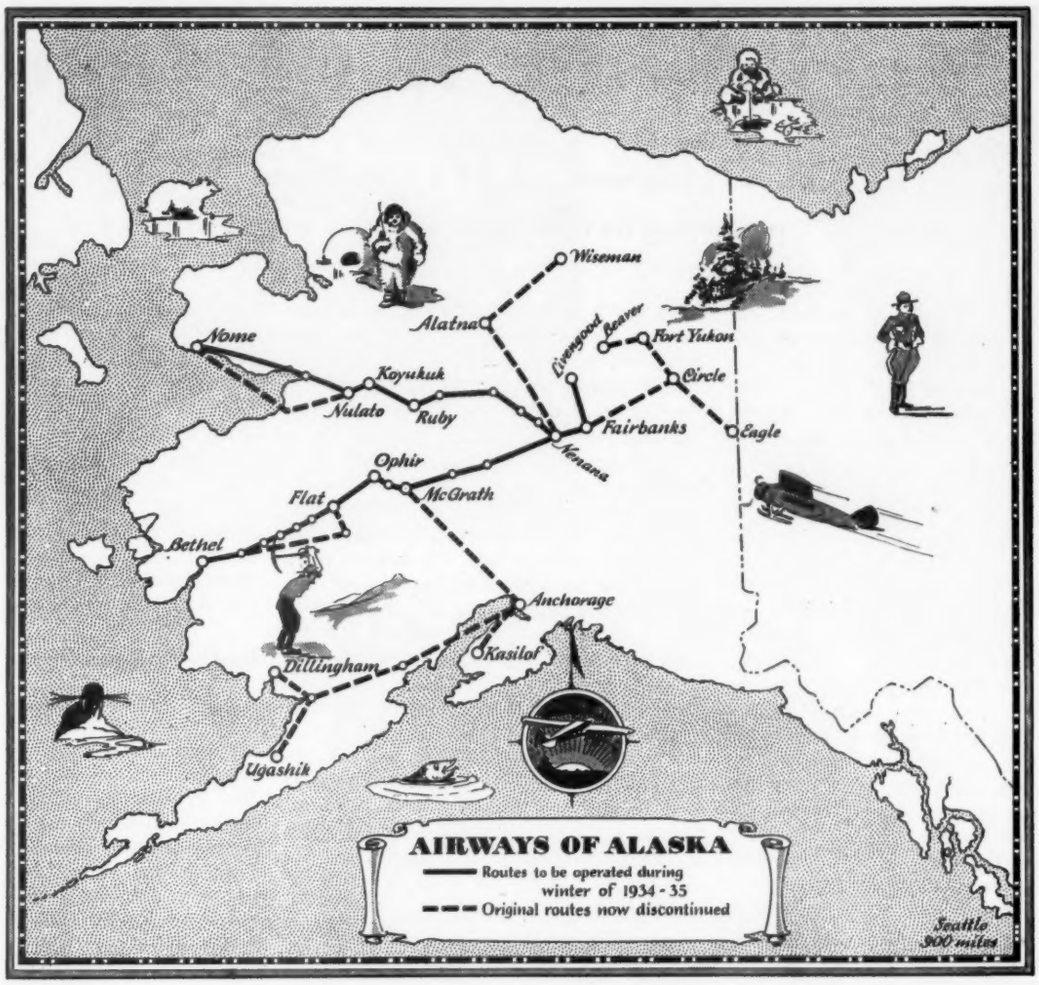
From an operating standpoint, the picture is now considerably brighter. For the coming winter contracts have been somewhat simplified and some of the least economic have been abandoned entirely. General traffic conditions have been smoothed over by the development of other types of payload. In each flight what capacity remains available after the mail is taken on is now almost invariably utilized for passenger or freight shipments. Contract and charter flying now forms a substantial substitute for mail contracts during the summer season. Miners, trappers, fur buyers, government officials, salesmen, big game hunters and tourists now use the airplane in Alaska more casually than they might in the States. There has been also a general acceptance of the airplane as an ambulance to ferry emergency cases, from broken legs to confinements, to the hospital in Fairbanks. Taken altogether Pacific Alaska Airways flies some 200 hours a month from September to June and at about half that rate during the slack summer season.

An evening's talk with the manager of Pan-American's Alaskan interests yields a good indication of the specific operating problems which had to be met and the manner in which they have been solved. These are not the conclusions of a theorist but represent knowledge gained through actual experience with a most difficult job. A few general principles emerge from an infinite variety of miscellaneous detail. Lack of space prevents a full and connected account, but a few of the outstanding points will serve to give a cross-section of certain requirements for Arctic operations.

From the previous contractors, PAA acquired a miscellaneous collection of airplanes and engines which, however, has been replaced to its present fleet of three Fairchilds (Wasp), one Fleetster (Cyclone) and one single engine Ford (Cyclone). The latter two ships have controllable pitch propellers. Normally, ships are mounted on skiis for winter operation and on floats for summer, but during the latter season, wheel gear is put on one or two for miscellaneous charter work into the interior.

Some of the present personnel have had prior Alaskan experience with former operators. The staff now consists of two executives, two traffic men, two radio operators, one field manager, six pilots, six mechanics, six helpers, and three so-called flight mechanics whose principal function, however, is to act as guides, accompanying pilots on long winter hops. These men are selected for their knowledge of the country and skill in judging the true characteristics of snow-covered rivers and fields where landings are required.

The single base at Fairbanks consists of a 100x100-ft. hangar of the usual corrugated metal Pan-American pattern, but provided with an inner wooden lining to back up 10 in. of sawdust insulation against the extreme cold.



To avoid undue loss of heat in the hangar when ships are brought in and out during the coldest weather, a sort of temperature lock has been provided by running a partition across the interior of the hangar between the door and the main shop and maintaining this area at a temperature just above freezing. Ships are then moved progressively into the shop through the vestibule section.

This building contains all the necessary facilities for repair and maintenance of both planes and engines with the exception of that needed for complete engine overhaul. When power plants must be completely torn down and rebuilt, they are shipped by boat and rail to the shops of Pan American Airways' Western Division at Brownsville, Tex. Incidentally, the Fairbanks Pacific Alaska station is the only authorized Department of Commerce repair shop in Alaska.

Except when in the shops for inspection and maintenance, ships spend most of their active life in the open. This is not only a necessity due to the almost complete lack of hangar facilities over the routes, but also is desirable to eliminate the condensation of moisture (and the subsequent liability to corrosion) due to exposure to varying temperatures. For the most part ships are allowed to remain at outside temperatures and the engines are prepared for starting by heating under canvas hoods with a couple of plumbers' melting pots. During the dead of winter it takes about two hours to prepare an engine for starting by this method.

Until recently, when the standard P.A.A. 87 octane fuel was adopted in Alaska, 73 octane gas was used satisfactorily. The principal fuel problem is in the transportation to outlying points.

Mid-winter operations

During parts of December there are only about three hours of daylight available for flying purposes, so many trips must be started before dawn. The situation is reversed in the summer when 20 hours out of 24 afford ample visibility. In winter each plane must carry an emergency kit of over two dozen items which include snow-shoes, rifle, engine covers, emergency rations, shelters, etc.

Weather reporting services in Alaska leave much to be desired at present. The Central Weather Bureau station at Fairbanks supplies twice daily reports which are based on reports from Signal Corps outposts scattered through the Territory. Recently governmental economies have cut down the number of such outposts by 22, a situation which leaves a number of undesirable holes in the Alaskan weather map.

Pacific Alaska operates its own radio station at Fairbanks but sees a need for additional smaller stations at terminal points to complete its communication system satisfactoriliy. The standard airplane radio equipment which was developed for the Caribbean Division has been transported bodily to Alaska and functions very well. The only change required was the provision of lubricating oil for the set which would withstand temperatures of 40 deg. below zero. Apart from the functioning of the set, occasional difficulties are encountered in radio communication from electromagnetic storms.

These are necessarily but a few of the highspots in the picture of sub-Arctic operations of the Pan-American System. For the future, operators dream of more and better airports in the territory to allow the use of wheels and skiis, particularly modern retracting gear. With a dozen modern airports and a few modern airplanes, the Alaskan operations would present another Grade "A" exhibit of aeronautical exploitation.

Caribbean Workshop

Pan American progresses toward a transatlantic service by perfecting its technique on lesser waters

WHEN Lindbergh's flight to Paris in 1927 reawakened general interest in an airplane service across the North Atlantic and the efforts of his emulators established beyond all doubt the complexities of such flying, there were a number of attempts made to predict the technical progress necessary before scheduled operations might become a reality. Wide divergence of opinion was to be expected, but it was generally agreed success hinged on:

1. The development of an aircraft (a) that would be capable of negotiating at least 2,500 miles with a practical payload, (b) that would be as mechanically reliable as any man made equipment can be and (c), in addition, would possess sufficient seaworthiness to be able to remain indefinitely afloat after a forced landing.

2. The improvement of flight instruments, radio, and navigational equipment to a point which would permit a safe encounter with any conceivable weather conditions.

3. The acquirement of sufficient climatological knowledge to determine the best available year round route, and the establishment of an adequate system of weather reporting and forecasting for the route selected.

4. The training of a highly specialized personnel competent to fly, maintain, and administer such a service.

It all seemed tremendously formidable at that stage of the art. Even the best of the land planes could not have carried enough practical payload to Europe to defray the necessary gasoline expense. Seaplane operations under line conditions constituted a completely unexplored subject at least in this country. Large flying boat design was also an unknown save that the tremendous DOX cast some doubt on its ultimate potentialities. Aircraft radio was still fundamentally experimental and of limited range. There had never been a forecasting service of any kind for the North Atlantic. For a development period, the more sanguine of the analyzers of the future considered a decade as a minimum, some mentioned two. A few proved by the cubic law of volume weight and the square law of sustaining areas that the project was hopeless.

Critics of the time failed, however, to grasp the significance of certain activities in the Caribbean. Pan American Airways was just beginning the extension of its routes across that body of water to South America in the face of a technical assignment almost exactly similar to that outlined in the preceding analysis.

Pan American needed aircraft that could operate over long stretches of water with the utmost reliability and withstand severe surface conditions if forced to alight at sea. It had to start from basic principles to learn to service flying boats under tropical line conditions. It needed more perfect instruments and navigation equipment. It needed the very best type of personnel. It had to create a weather service that could follow rapidly moving storms at sea. It not only needed such things ultimately in highly perfected form, it had to develop them to a substantial degree in a minimum of time in order to operate at all.

Search for equipment

From the very outset the company became the best friend and severest critic of the American commercial flying boat industry. The variety of flying boat equipment available in 1928 and '29 was very limited. In addition it became very quickly apparent that what little equipment was available would require a great deal of modification and development due to the fact that there is a big difference between casual flying and commuting in a temperate region well equipped with excellent landing fields and large harbors, and operating over regular scheduled routes in the tropics, where limited fields and unpoliced harbors are standard conditions. With the earliest of the amphibion models developed for the service there were corrosion difficulties, there were maintenance complexities, there were troubles with excessive spray, there were changes desired in seating and equipment arrangement. The result was a closer liaison between the engineering department of the operating company and the manufacturer than has ever been previously effected. Together they worked out changes in old models and specifications for new ones. As the development progressed it was found possible to abandon the amphibion feature altogether. To do so saved weight and maintenance and airport upkeep.

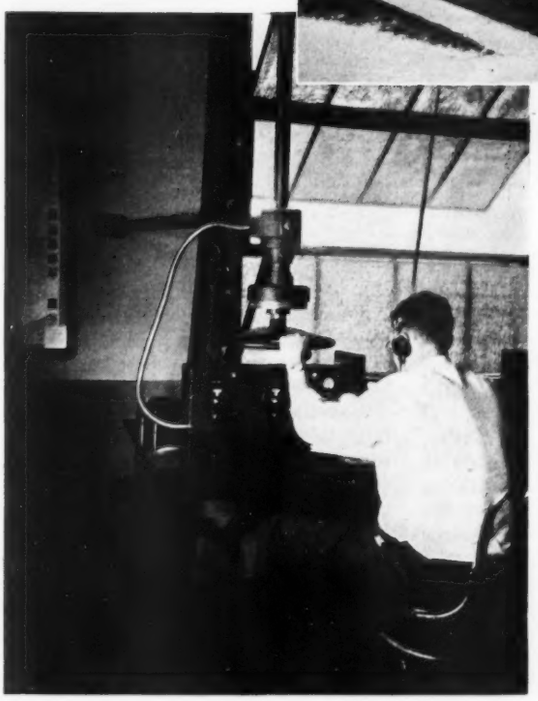
The routes of the Caribbean Division were slow in taking their permanent form, changing frequently as the means grew available for rendering more efficient services. From the beginning it was felt desirable to develop a direct service between Miami and the South American Coast. With a stop at Kingston this meant an over-water hop of more than 500 miles. For it the Sikorsky S-40s, the world's largest amphibions, were developed and launched late in 1930. By the next spring the service had been opened and shifted to its present route Miami-Kingston-Baranquilla.

Radio and weather

Equipment development was, however, only a part of the program. A survey of the entire radio field in 1927 and '28 had yielded no equipment suitable for ground or plane communications under tropical conditions. Radio phone communication seemed hopeless in the face of the range and static requirements. The company's radio experts therefore boldly undertook the development of their own code equipment. Their efforts were crowned with remarkable success. Soon, they were able to establish a complete network of ground stations and equip all the system's aircraft with standard, highly efficient apparatus which has not only proven adequate under the severe conditions of the Caribbean but which have functioned equally well in the sub-arctic, across the Andes, and for communicating with ships on the high seas.

With the solution of its radio problem Pan American could proceed with the organization of its meteorological network. It found some semblance of meteorological services in several of the countries through which it operated, but in general it had to base its forecasts on reports from its own radio stations and from surface vessels available along its over-water routes. Courses have been established in the technique of weather observation and forecast interpretation which are required of all radio operators and base managers. Forecasts are prepared thrice daily at each division headquarters and broadcast to all stations to supplement the regular along-the-line reports from objective stations required before any departure. Chief of Caribbean difficulties has been to provide adequate notice of tropical hurricanes and of intense tropical storms usually of highly localized character.

On the bridge of an S40 Clipper in Caribbean Service. The S42S will also carry a robot.



Operating a Pan American radio direction finder. Above: The loop of the direction finder on the roof of a terminal building, at Miami.

The Caribbean Division has never had a fatal accident to passenger or crew due to weather, or any other cause.

The formidable maintenance problems fell before an infinite capacity for taking pains. There are many difficulties which differentiate Pan American maintenance from the domestic variety; supplies, facilities, and skilled personnel must be spread along a long thin line between division headquarters. Cramped muddy airports and unpoliced harbors take a toll from landing gears and hull bottoms. The climate hastens corrosion and makes gasoline storage unreliable. But there are also alleviating circumstainces; schedules are relatively infrequent; the minimum possible staff required by the geographical disposal of the routes gives a ratio of personnel to plane probably in excess of that common on domestic routes. The result is a thoroughness of inspection, an attention to details almost without parallel in airline operations.

Pilots-of-all-trades

An ideal crew for a transatlantic airliner as Pan American conceives it will need to be as talented a group as ever took ship off water. A group of five specialists to divide a multiplicity of duties is efficient only so long as they can all maintain their keenness and alertness against fatigue. A group of five, however, each one highly trained in all the necessary fields, flying, maintenance, navigation, meteorology, radio, can properly divide the tasks to permit sufficient rest and relief from strain from the longest of hops.

Toward this ideal the system has been constantly aiming. All pilots are trained under expert supervision in maintenance as well as in piloting, navigation, and radio. New pilots, regardless of their experience, must pass through a step by step process of advancement. On completing their courses they are required to serve for some time as Co-Pilot on each route, to which they are assigned. A Senior Pilot is a very complete individual whose time is well into the thousands of hours. He has had experience on a wide diversity of craft. He is familiar with the routes and weather of practically every division on the system. He has been fully trained in instrument flying. A Master Pilot selected for transatlantic command would in addition be something of a diplomat, a bilinguist at the least, and an expert in customs regulation and practical international law as it affects his activities, in every sense a true commander of his ship.

Since the opening of the Jamaica-Baranquilla run this general preparation has been headed even more directly toward the transatlantic ideal, for the S-40 crew is the same size and has the identical functions of our ideal transatlantic group. They must fly, they must co-ordinate and tend a multiplicity of engines, they must negotiate weather of all types, they must navigate by dead reckoning, by celestial navigation, and by radio bearings. Even the radio operator is becoming more and more identified with the general flying personnel although most Pan American planes still carry radio specialists.

The S42s will be another step, for they will remove all limitations of scale. The crews that pass through training periods on them will be finally ready. Ready for a transatlantic service if that is ever made commercially possible, ready in any case to render a service on the Latin American routes unmatched anywhere else on the globe.

Meteorological Resources for Transatlantic Service

AN INTERVIEW WITH

Dr. James H. Kimball
Meteorologist, U. S. Weather Bureau

AERONAUTICAL people, used to the extensive weather services available along our domestic air routes, have little appreciation of the fact that before the outbreak of ocean flying there was simply no such thing as a forecasting service for the North Atlantic. When René Fonk's navigator walked into the New York office of the Weather Bureau and asked to look at the day's map and forecast for the route to Paris, there was nothing to show him beyond the pilot chart for the month and a mass of observations for climatological purposes which had been mailed into the bureau by shipmasters from voyage terminals.

The fragmentary, temporary forecasting service based on radio reports from ships at sea which was set up for that flight and the ones that followed were actually the first thing of the sort the Bureau had ever operated. Even the NC and Round-the-World flights had been served by reports from the Navy.

The progress that has been made in the intervening few years toward an Atlantic meteorology adequate for scheduled transoceanic flying, seems therefore no less remarkable to the weather expert, than the more spectacular advances made by the airplane designer and radio engineer in the same period.

The basic climatology which was available to the flyers of the late twenties was quite extensive, and of very definite use in determining their most probably favorable route at the various seasons of the year they undertook their flights. Based on the many thousands of shipmasters' reports collected over a long period of years, prevailing winds, temperatures, and pressures had been plotted on monthly charts for the whole oceanic area and a great deal was known about the probable tracks of the larger storms.

But extensive as this material was, it seemed by no means sufficient evidence upon which to base the selection of a route for year-round operations, and upon which to plan the details of operation necessary for the organization of an airline.

Fortunately a large amount of additional information has been forthcoming. The number of stations in Eastern Canada has been increased. The regular services in Greenland and Iceland have been improved. The Pan American Airways and a British group have spent several seasons adding to the climatology of interior Greenland. With the exception of the Labrador coast our data of the conditions along the northernmost route have therefore been substantially increased, and the survey flights by Von Gronau, Cramer, Lindbergh, and Balbo have greatly stimulated the co-ordination of all the new and old material. Along the Bermuda-Azores route there has been less additional observational activity but both the Pan American and the Imperial Airways have made extended efforts at co-ordinating existing data.

Old records valuable

But the greatest advance in oceanic climatology has resulted more from a restudy of old records than from an accumulation of new ones. The reports collected by the Marine Division of the Weather Bureau had always contained more material than had ever been used, data largely on the "state of the weather," records of "overcast," "rain," "passing showers," "high visibility," etc. Such material takes on an increased interest in meteorological analysis by the air mass and frontal method. It is an indispensable basis for the modern ideal of a "dynamic" climatology.

The small staff of the Marine Division was obviously unequal to the task of extracting and collating the literal millions of such observations in the files. The CWA with its white collar employment relief program, therefore, seemed nothing less than Heaven-sent. Thanks to it, over 200 people worked throughout the past winter, extracting data from twenty years of records, and entering it on specially designed cards that can be sorted mechanically by region, period and character. Much of the information so gathered has already been worked into the pilot charts. More is available for study by specialists.

Two topics on which even this new study is incomplete are those of thunderstorm frequency and upper air data. But even without these important aeronautical desiderata there seems ample basis already on hand for a definite evaluation of the proposed routes.

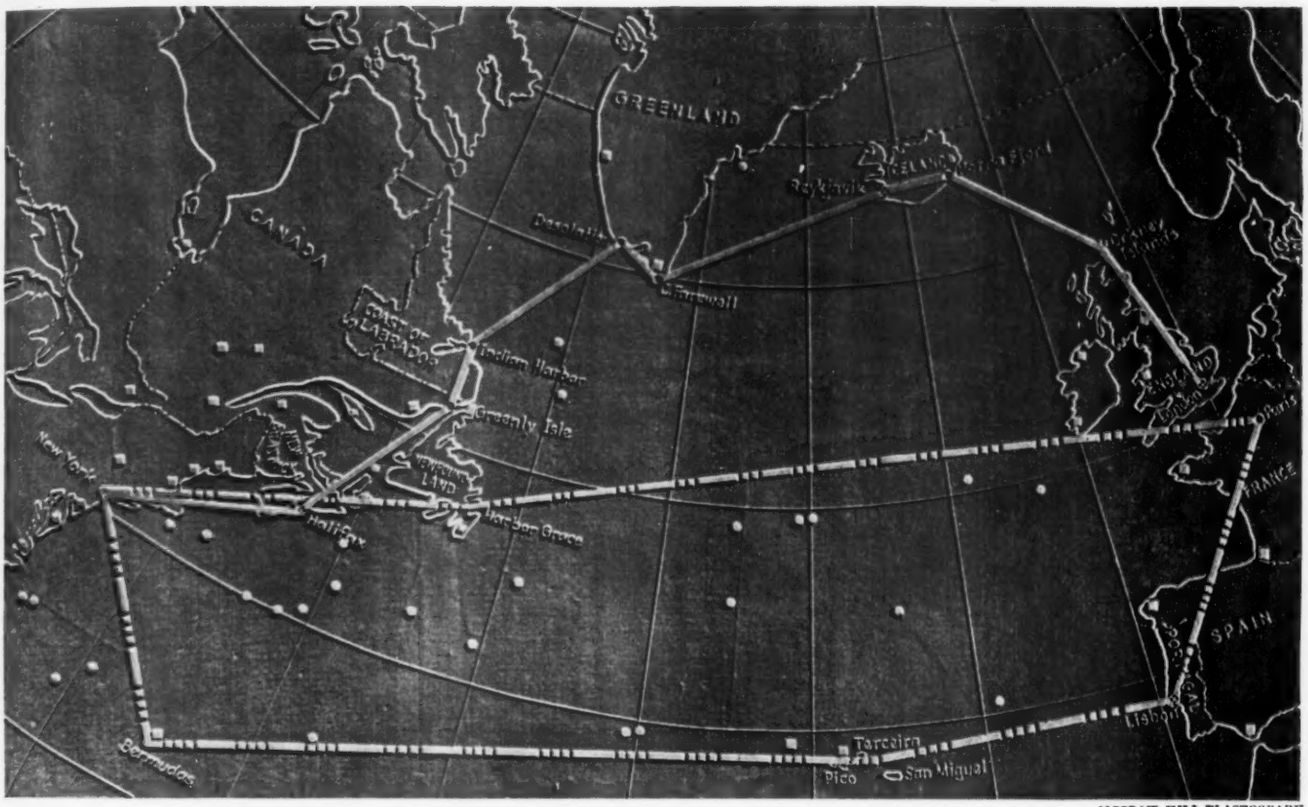
But there is a deal more up-to-the-minute weather service needed for flying than even the most perfect set of climatological charts imaginable, as the greenest flying student can tell you, and in that department we have come a tremendous distance since 1926.

One cannot quite say that the whole present program of twice daily reports from hundreds of ships is entirely due to the demands of the ocean fliers, but at least it was their impetus which finally gave form to a project which had been long discussed and desired by the shipping interests.

The first synoptic maps drawn for Fonk were based on a few scattered reports collected specially for the purpose by the Radio Corporation of America. For that summer and for several years thereafter, the service was set up at what one might call the beginning of the ocean flying season and discontinued after the last of the aspirants had taken off or definitely cancelled his project.

The service had never been limited to this side of the Atlantic and since the international meteorological conference at Copenhagen in 1929 the efforts of our own bureau and those of the European nations was co-ordinated into a regular twice daily oceanwide reporting from a large number of ships of almost every maritime nationality.

A typical spotting of the reports of interest to the North Atlantic flying route region is shown in the accompanying map. Not all the reports are received through the same channels. Those from the American coastal region, and the Caribbean and Gulf waters are transmitted to U.S. governmental stations and relayed to the bureau. The European coastal region reports are collected in England and transmitted from the station at Rugby. Incidentally when more information on Eastern waters is desired, it is readily available, but only enough reports are transmitted to America for purposes of



McGRAW-HILL PLASTOGRAPH

A typical spotting of reporting stations for the present twice daily North Atlantic forecasting service. Round dots represent reports from ships; squares the shore stations of greatest importance to the maritime forecast. Locations taken from the forecasters' map for the morning of July 16, 1934. The projection is that used by the Canadian Topographic Survey.

general forecasts. The reports from mid-ocean come partly in these two reports but many of them, especially along the steamship lane to Europe are still forwarded through the co-operation of the Radio Corporation.

In general the ships equip themselves with what few instruments are needed beyond their standard equipment, take observations at pre-arranged times and of standardized types, and transmit the results at their own expense to shore stations or in some cases to other ships for relaying.

The governmental weather bureaus inspect and calibrate the instruments whenever the ships are in port, collect the reports from all sources, prepare forecasts and rebroadcast them from their most powerful stations. In this country, maps and forecasts are prepared in both New York and Washington, and the broadcasting is done from Arlington.

A study of the accompanying map indicates certain strengths and limitations of the service. There are at least 150 ships on the North Atlantic properly equipped and enlisted in the International Service and as many more in other oceans. There are enough of these at sea at any particular time to yield something more than a hundred reports for the Atlantic above the equator.

Obviously, these reports tend to give much more complete information along the active ship routes than elsewhere. There is excellent coverage from New York to the English Channel along the steamer track and in the Caribbean and the Gulf of Mexico. There is satisfactory coverage along the American and European Coastal routes and there are frequent reports from ships plying between the principal ports of North and South America, Europe and Africa.

Air route average

Considering the aerial routes, both the Great Circle and Greenland route regions are very sparsely frequented by ships, and both these routes suffer from a lack of stations in Labrador.

Along the Southern route the areas between the American coast and Bermuda, and the European coast and the Azores are amply patrolled. The region between the two island groups considerably less so, the several reports indicated on the map as originating there being rather exceptional.

There are two possible ways to insure better reporting along this the greatest single gap on the route. First the stationing of one or two permanent patrol ships in the area following the Westfalen precedent. Second the establishment of collecting centers at the islands and the equipping of the local shipping and fishing fleets with instrumental and radio equipment. Both would probably be resorted to during at least the early years of a scheduled service.

Furthermore it must be borne in mind that the present service is designed primarily for the benefit of the shipping at sea and for the use of meteorologists in preparing their land area forecasts where they are influenced by maritime conditions. For airline operations especially over limited regions of special interest the frequency of observations, their detail, and even the number of reporting ships could be increased "almost for the asking."

It's a long way, all this, from the half dozen badly located ships which furnished the information for the "Lindbergh Map," but there is still a lot to be done in the future. If the full possibilities of the air mass method of analysis are to be extended to the maritime work a great deal of upper air sounding work will be needed similar to that being so rapidly increased in this country, but such work presents particular difficulty at sea. Even pilot balloon observations for the study of winds aloft is still limited to a few naval vessels and the ships of scientific expeditions, and suffers in accuracy from any pitching or rolling of the ship's deck. But if these data are found to be indispensable, some means will probably be found to get them. The airplane has so far shown a very consistent tendency to help solve its own meteorological problems.

Performance Plus

The combined experience of operator and manufacturer have produced in the Brazilian Clipper, an airplane of outstanding merit as a high-speed, long-range load carrier.

A PURSER in the trim blue of Pan American Airways stands at the foot of the companionway, checking the manifest: Lindbergh, Trippe, Vidal, Sikorsky, Priester, Musick, Franchimont, Neilson, and several others representing magazines and press until 31 names have been entered on the ship's roster. Quickly a flight mechanic unships the Jacob's Ladder astern, takes in hand rails on the afterdeck, closes the hatches. Overhead a distant rumble, as one after another of the 700-hp. engines come to life; the order to cast-off is given, and the Brazilian Clipper stands out into the Housatonic River. Out in Long Island Sound waves are running 2 to 3 ft. from trough to crest, but the ship rides with scarcely a ripple. On the down-wind side the wing tip float cuts through the water like a racing boat. Out in the open water, past the end of the breakwater, the ship pivots into the wind. For an instant engines idle without sound, then, full throated, 2,800 horses leap into action and 17½ tons of metal, fuel and human cargo seem to leap into the air.

Watches in hand, delighted observers in spacious cabins argue whether she got off in 16 or in 17 seconds. Faces peer through portholes to watch trailing edge flaps, depressed during takeoff, move slowly upward to high speed position. Conversation, congratulations, discussion criss-cross each compartment with little interference from the Hornets overhead. Passengers relax into deep cushioned chairs watching the panorama of Bridgeport wheeling by below as S-42 circles to permit photographic planes (lumbering along at a mere 130 m.p.h.) to record the progress of her flight for news reel watchers of the coming week. Having thus paid her respects to her public, she points her nose to the Northeast and streaks off at 160 m.p.h., soon outdistancing the flying newshawks.

New Haven is below the horizon and New London well astern before she swings around to retrace her course. Up and up she climbs until altimeters show 6,500 ft., then, levelled off, throttles are opened wide. Airspeed climbs close to the 190 m.p.h. mark.

Soon Bridgeport is in sight again, and after a wide circle, with flaps down the ship drops into the choppy water so quietly that flying boat experts on board look at one another in astonishment. Taxiing in on the step, the big boat is soon within mooring distance of the ramp. Movie cameras and microphones are waiting expectantly in a circle for the formal presentation of the license by Aeronautics Director Vidal.

The flight of July 3 was somewhat more than a press demonstration. It was one of a long series of test flights at the hands of pilots Lindbergh, Musick and others to check against Pan American Airways' set of rigid specifications. Day in and day out, under all sorts of weather, sea, and loading conditions, the work has been going on. Fat notebooks bulge with charts and curves, reams of paper have been covered with observers' notes. When all is summed up, in no respect has S-42 fallen short of the purchaser's specifications, and in practically all departments it has exceeded the designer's computations.

I. Performance test notes

THE design load licensed by the Department of Commerce is 38,000 lb. Indications are that for certain purposes a gross weight of 40,000 lb. can be handled. In the engineering tests with the 36,000 lb. load, average take-off time

ranges from 17 to 26 seconds, depending on the wind velocity and waves. With 38,000 lb. gross, the averages run from 18 to 32 seconds. Again, from engineering tests, the boat climbs 1,000 ft. per minute from sea level up to 3,500 ft. with 36,000 lb., 850 ft. per minute with the 38,000 lb. gross. A record altitude, attained in 47 minutes with a gross load of 38,000 lb., was 15,456 ft. Somewhat more lightly loaded (33,500 lb.), the boat went to 20,406 ft. in one hour flat. Both these altitude figures have been homologated by the F.A.I. as new world records.

As for speed, with the 36,000 lb. load, full throttle at sea level, the average was 182.5 m.p.h. Cruising at 75 per cent power at sea level, the speed is 160.0 m.p.h. At full throttle and 650 b.hp. at 5,000 ft., however, the ship has been clocked at 188.0 m.p.h. Another test indicated that with 73.5 per cent power at 7,800 ft. (36,000 lb.) the cruising speed was 171.0 m.p.h.

Beyond the two records already mentioned as homolgated by the F.A.I. eight other world records, long held abroad, fell to the S-42 in a full load test flight on Aug. 1. The 1,000-km. speed record for flying boats without payload restriction was raised by almost 20 m.p.h. to 157.7 m.p.h. In the seven other record categories the increases in performance over former marks was equally spectacular. These tests were made over a 311-mile closed course in the vicinity of New York City.

Engine combinations

As a multi-engined ship, the performance on various engine combinations is also of considerable interest. With any three engines operating (delivering 670 hp. each) 154.1 m.p.h. average has been measured over the speed course. Reducing engine output to 575 hp. each, a velocity of 142.2 miles per hour was measured. At 10,000 ft., with a gross load of 33,300 lb., level flight at 144.0 m.p.h. (at low pitch) was maintained on three engines. At a forward speed of 108 m.p.h. (gross load 36,000 lb.) the ship showed a rate of climb of 400 ft. per minute at 7,600 ft. and 500 ft. per minute at 4,000 ft. These climb tests were made with the propellers in the low pitch position.

A few tests have been made on two-engine performance. With a gross weight of 27,500 lb., level flight was maintained at a speed of 112 m.p.h. at an altitude of 4,300 ft.

During all tests Hamilton Standard three-bladed, two-position controllable pitch propellers were fitted. Each are 11½ ft. in diameter. The low pitch setting was 20 deg., the high 26 deg.; a setting designed to give best efficiency for cruising at 5,000 ft., and to give best takeoff with full load.

The normal landing speed (with the flaps down at approximately 37 deg. to the chord) is 65 m.p.h. with an all-up weight of 36,000 lb. Landings have been made with the ship under all possible conditions of flap setting and load. The 65 m.p.h. landing can easily be attained and, in fact, the ship has been landed with full load, in a light breeze at speeds as low as 62 m.p.h.

TABLE I
Required Equipment

A. Pan American Airways Specification

	lb.
1. Hat Holders	3.0
2. Fish Oil	9.0
3. Flash Lights	1.75
4. Hand Axe	2.0
5. Hand Axe	2.0
6. Utility Ropes	14.00
7. 10 qt. Pail	2.0
8. Air Rafts (1)	46.0
9. Air Rafts (2)	94.0
10. Spare Parts Kit	45.0
11. Automatic Pilot	110.0
12. Flit and Spray Gun	2.5
13. Machete	2.5
14. Paper Cup Holder	2.0
15. Radio Wiring	39.0
16. Food	100.0
17. Life Jackets	93.0
18. Anchor	200.0
19. Anchor Cable	20.0
20. Fog Horn	.5
21. Ship's Bell	1.5
22. Very Pistol and Cart	7.0
23. Boat Hook	4.0
24. Heaving Line	4.0
25. Waste Can	4.5
26. Water Canteens (3)	30.5
27. Bilge Pump	7.0
28. Sea Anchor and Line	10.0
29. First Aid Kit	3.0
30. First Aid Kit	3.0
31. P. and W. Tool Kit	16.0
32. Water Containers	108.0
33. Food Box	23.0
34. Tables	60.0
35. Coat Rails	5.0
36. Smoking Stand	4.0
37. Table Rack	7.0
38. Life Buoy	3.0
39. Fire Extinguisher	14.0
40. Fire Extinguisher	14.0
41. Entrance Ladder	9.0
42. Drinking Fountain	36.0
43. Towel Holders	2.0
44. Paper Towel Holders	2.0
45. Sanitary Pad Holders	1.0
46. Signs and Frames	5.0
47. Magazine Holders	4.0
48. Batteries	130.0
49. Landing Lights	24.0
50. Generators	40.0
51. Towing Pendant	10.0
52. Pilots' Seats Cushions	23.5
53. Safety Belts	37.0
54. Anchor Winch	43.0
55. Radio Table	5.0
56. Radio and Mechanic's Seat	30.0
57. Carpets	60.0
58. Curtains	12.5
59. Steward's Seat	9.0
60. Radio complete	92.5
61. Radio Mast Antenna	10.0
62. Parachute Flares	50.0
63. Misc. Books, etc	5.0
64. Entrance Railing	4.0
65. Strong Box	9.0
66. Cupboards	10.0

B. U.S. Department of Commerce specification

67. Starter Handles	5.0
68. Starters (4)	80.0
69. Ring Cowlings (4)	176.0
70. Engine Fire Extinguisher	80.0
71. Oil Regulators (4)	60.0

C. Totals

Total Equipment	2,181.0
Weight Empty, no Equipment	19,764
Weight Empty as Equipped	21,945

Weight schedules

Performance of this order is in itself an indication of first-rate design, but when in addition we take into account the weight characteristics of the airplane, the design is clearly not only first rate but extraordinary. The empty weight (dry) of the entire structure is but 19,764 lb. On the basis of the 38,000 lb. gross licensed for take-off, this leaves 18,236 lb. that can be assigned to useful load, a ratio of useful to gross of a high order (48 per cent). Fuel and oil accounts for 7,995 lb., extra equipment (including that required by Pan American Airways and the Department of Commerce—see Table 1) amounts to 2,181 lb. A crew of five (two pilots, flight mechanic, radio operator, and purser) is regularly carried, which leaves slightly over 8,000 lb. for actual payload. Thirty-two passengers at the conventional allowance of 170 lb. each, comes to approximately 5,450 lb., leaving roughly a ton and a quarter available to take care of baggage, mail, express and other cargo.

II. A Glimpse Under the Skin

TRANSPORT airplanes are no longer the product of the genius of any one man, or even of any one group of engineers, and the S-42 is no exception. Into the specifications went the accumulated experience of Pan American's seven years engineering and flying operations; into the design went the accumulated knowledge of Igor Sikorsky and his aerodynamicists, stress analysists, and craftsmen. Differences of opinion there were a-plenty, but by the closest sort of co-operation between purchaser and manufacturer, interminable conferences and an incredible volume of work, results were brought into agreement, and very severe requirements were turned into accomplished facts.

We have covered the external features of the ship in earlier articles (AVIATION, March-April, 1934) and a few of the special arrangements introduced to facilitate maintenance are discussed on page 273 of this issue.

The hull

The main hull framing consists of a deep girder keel of which stem and stern post are integral parts. Flanges are of extruded dural section, the web of dural plate, assembly by riveting. Eight built-up bulkheads (each equipped with leak-proof doors to divide the hull into nine watertight compartments) and a number of lighter intermediate formers

constitute the transverse framing. Two of the bulkheads about amidships carry triangular sections extending upward beyond the normal deck line to form the supporting tower for the wing. They are also heavily reinforced at the water line to take the wing strut and beaching gear fittings. All frames and bulkheads are tied together fore and aft by extruded dural channel gunwales and extruded angle chines. Light Z-bar stringers run longitudinally from bulkhead to bulkhead to back up the bottom plating, and a number of light longitudinal omega sections reinforce the sides and deck. The entire hull framing is assembled by rivets. All seams are sealed with impregnated fabric during fabrication. Heat treated and anodized duralumin is used throughout, except for the main wing attachment fittings. which are forged steel.

Hull plating is of 17-S aluminum alloy. Flush riveting is used throughout, so that the external surfaces are smooth and unbroken by rivet heads, a factor that makes an important contribution to performance. The rounded deck is also reinforced by light external omega sections running fore and aft. Toward the stern they are curved down to the gunwales along lines of airflow as determined by wind tunnel tests on a model. Wherever the hull shell is pierced for hatchways, emergency exists, windows, etc., adequate reinforcement is provided around the openings to prevent local buckling at such points under severe stresses. Throughout the structure, especially in the lighter frames, stringers and stiffeners, plain or flanged lightening holes have been punched out.

The wing floats are of the same general type of construction as the main hull. They are made up of duralumin framing covered with dural sheet.

The Wing

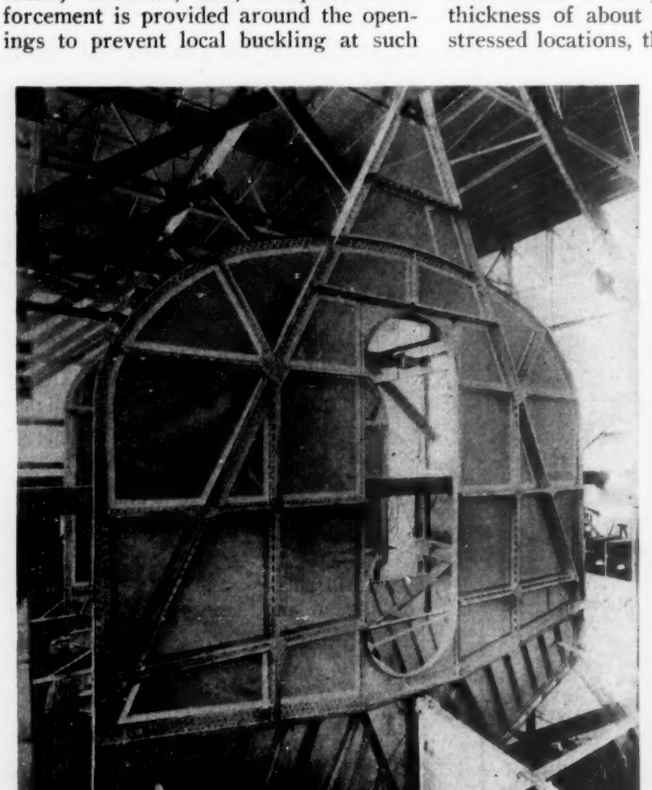
The special GSM-3 airfoil section used has a very high maximum lift coefficient and a high value of L/D in the lower portions of the lift curve. The monoplane wing of S-42 is of the two spar, stressed skin type. All areas—top and bottom surfaces—ahead of the rear spar are dural sheet covered. Aft of the rear spar, and on the extreme tip sections beyond the ailerons, fabric covering is used. The tip sections are made watertight to provide flotation in emergencies. As on the hull, all rivets are of the flush type giving smooth external surfaces.

The two spars are continuous from tip to tip. They are of a modified Warren truss type and are composed of dural extruded and built-up sections assembled by riveted and bolted-on gusset plates. For the flange members of both beams a standard duralumin extruded section has been developed which is most ingenious. In cross-section it is a modified *C* shape with a uniform thickness of about 3/16 in. In highly stressed locations, the basic section may easily be reinforced by the insertion of telescoping half-round tubular liner of steel or dural. Where full strength is not needed, and lightness is paramount (for example, as the wing tip is approached), the flanges, or the flanges and a portion of the side walls may be cut away between gusset stations. Both types of modification appear in the S-42.

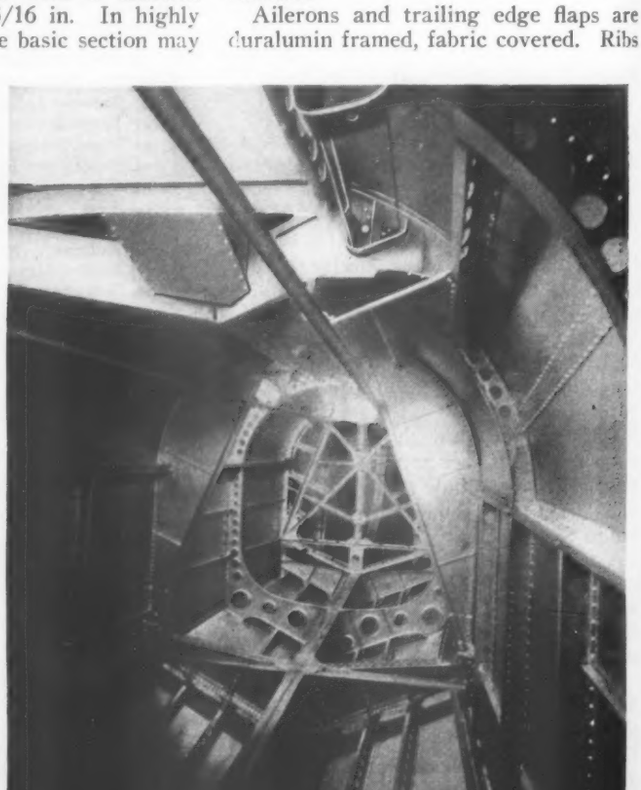
In the highly stressed portions of both spars (through the center section supporting engines and fuel tanks) where the bearing pressures on the rivets connecting flange and web members run into high figures, steel bolts have been substituted for the dural rivets used in the rest of the structure. All such bolted connections are safetied by the use of A.G.A. Elastic Stop Nuts. A large number of this type of fastening device is used elsewhere in the ship for various purposes.

Drag members built of rolled dural shapes rivetted together join front and rear spars at frequent intervals. These are also of the Warren truss pattern. In the center section the fuel and oil tanks are supported on cradles which are integral with the drag bracing trusses. Solid web girder type former ribs alternate with the drag members in the tapered portion of the wing outboard from the engine mounts. Behind the rear spar, ribs of extruded dural *T* and channel sections support the fabric surfaces.

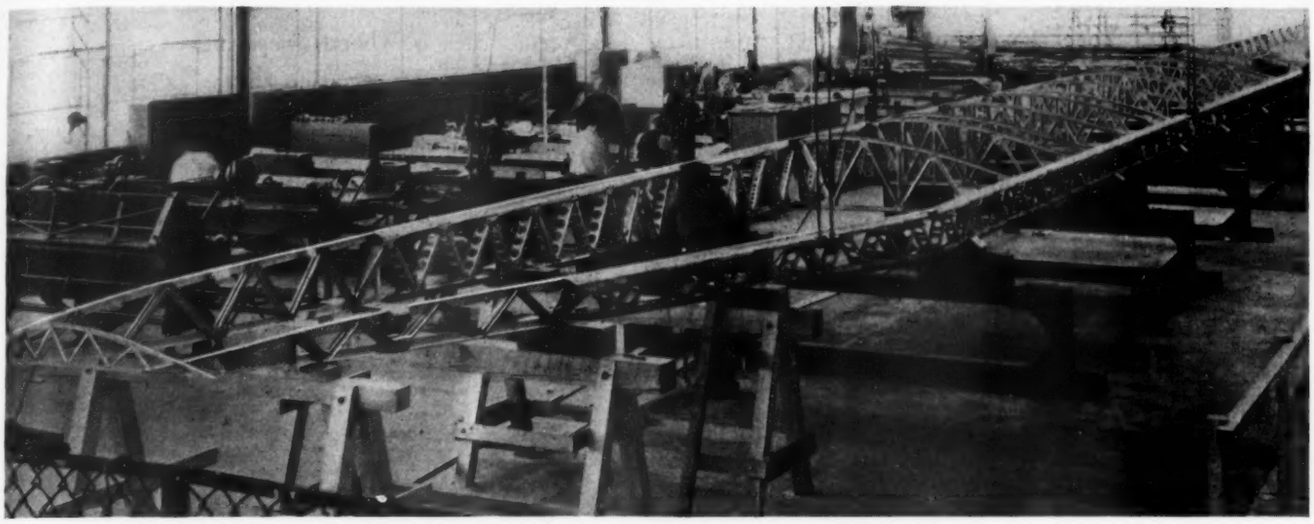
Ailerons and trailing edge flaps are duralumin framed, fabric covered. Ribs



The main bulkhead is extended downward to form the front step and upward to provide the rear superstructure bulkhead to which the rear wing spar is attached.



An interior view of the tail structure showing the stabilizer adjusting mechanism and some of the control cables. The accessibility for maintenance is notable.



The ingenious spar construction is shown in this photograph of the partially completed wing.

are of stamped dural fitted over tubular spars. Hinges for the movable surfaces are cantilevered out from false spars on brackets welded up from pressed steel sheet. False spars are connected to the rear spar at each drag strut connection. Ball bearings are used throughout. Aileron control is of the cable and pulley type, the cable from each aileron running in toward the center section where it is attached to a yoke for differential action. Cables actuating the yoke run directly to the cockpit.

Flap mechanism

The multiple-position flap control mechanism is novel. It is hydraulic, with control handles suspended from cockpit roof near the throttles. Master actuating cylinder and oil distribution valves and manifold are located in the rear of the tower section behind the rear spar attachment fitting. The master cylinder pulls the flaps down through direct cable and pulley connections to control horns. The flap is raised by the action of six small cylinders (three to each flap section) mounted in the trailing edge of the wing, with plungers direct connected to the flap horns. An ingenious arrangement of pressure relief valves and by-pass connections makes it impossible for the air loading on the flap surfaces to exceed a predetermined safe figure. For any flap setting, if air speed is increased so that loads become excessive, the pressure in the hydraulic system releases itself enough to allow the flap to rise until the loading is within the normal range. As air loads ease off the flap automatically returns to its original position.

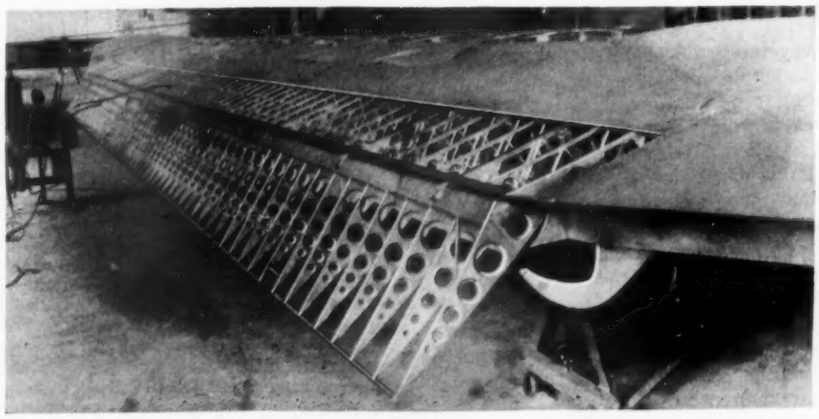
The external wing bracing system differs radically from former Sikorsky patterns. The large streamlined tubular struts which extend diagonally toward the wing from forged steel fittings on the sides of the hull just above the water line are of 24-S alloy, the only usage of this material on the entire ship. The large struts are not carried clear into the wing, however, but end a number of feet below the intersections, and stainless steel streamlined tubes of very much smaller cross-section are used from that point on into the wing spars. Reduced interference drag at the intersections is the reason for the modification.

Tail surfaces have dural spars and ribs, and are fabric covered. They are carried on the after part of the hull proper. The entire unit, both horizontal and vertical surfaces, is hinged at the front stabilizer spar, and longitudinal trim is obtained by raising or lowering the rear spar by means of an orthodox thread and block mechanism. The entire adjustment unit is completely accessible from inside the hull. All hinges have ball bearings.

Power plants

Supports for the four Pratt & Whitney S3D1-G engines are entirely conventional. The welded steel tube frames are bolted directly to forged steel fittings on the front spar. No attempt has been made to insulate engine mounts with rubber. Practically no vibration from the engines is noticeable in the cabins. It seems likely that the great mass of the wing structure and its connections to the hull can be relied upon to dampen out vibration from this source. Mounts and fittings are made up with great precision so that all are interchangeable. Controls for all engines come up into the wing from the hull through the supporting tower, and along the front face of the forward spar to the several nacelles.

Fuel is carried in eight elliptical riveted dural tanks of about 150 gal. each carried by the drag trusses between the wing spars. Tanks are arranged in pairs behind each engine mount with a smaller tank for oil between each pair. Valves are remote controlled, so that no fuel piping at all enters the hull structure. Protectoseal filler caps are installed on all tanks. Two tanks on each side of the wing are fitted with quick-acting Durex dump valves so that their contents may be quickly jettisoned at any amount desired in emergencies. Lux CO_2 pressure fire extinguishers are fitted to each engine and tank installation and are controlled from the cockpit.



The uncovered flap, showing its construction and attachment to the wing.

Since the National Advisory Committee for Aeronautics has been operating the new towing tank at Langley Field there has been a new appreciation among designers of the practical value of research with this type of equipment. In the accompanying article Mr. Truscott, who is directly in charge of this work, outlines the design problem for large flying boat hulls and discusses the present and future potentialities as well as the limitations of the towing tank in this type of design.

Designing Big Boat Hulls

By Starr Truscott

Chief, Hydrodynamics Division
National Advisory Committee for Aeronautics

THE HULL of a large flying boat such as the S-42, represents a whole succession of engineering decisions and compromises between the demands of conflicting requirements. Theory and practice influence each decision regarding the major characteristics that must be considered. In many features theory, recognizing its own incompleteness, turns frankly to practice for present decisions, yet looks hopefully to a time when more complete information will permit more accurate recommendations.

Part of the necessary information must come from statistical studies of results from actual operation, but many of the data must be supplied by research and the experimental model basin is one of the principal tools used in the work. Of the three towing basins in this country only the N.A.C.A. tank is devoted soley to work intended to improve the performance of seaplanes and flying boats on the water. It may be of interest to any who may think that the equipment of the United States for Aeronautical Research is unusually complete, that there are three tanks in Great Britain devoted to seaplane research alone.

Since the model basin is one of the principal tools it becomes necessary to survey the problem of the big boat hull as a whole and see how the various parts can be attacked so that the proper bases for the various compromises may be supplied. It should be understood that this discussion does not describe an official program of the National Advisory Committee for Aeronautics but only some quite unofficial thoughts regarding the general problem and methods of attacking it.

Tabulation of the various characteristics on which information was required led to the realization that there were a great many, but that apparently they could be grouped under five main divisions. Each of these required consideration in connection with the maneuvers naturally expected of such a craft. The whole seemed best expressed in tabular form in the chart on page 251.

As seen in the chart, the maneuvers are divided first into those concerned with operation on the water and in the air. In general the water maneuvers are determining factors in the design of a flying boat hull so attention may be directed mainly to them. Maneuvers on the water in turn are divided naturally into those with power off and those with power on. In this case "power off" means that the propellers are not exerting a thrust sufficient to become a factor in the problem; "power on" means that they are. Clearly the hull characteristics while anchored or drifting, either freely or to a drag, come under the head of maneuvers with power off. Likewise characteristics while taxiing or taking off are maneuvers with power on. Landing may be done "power off" or "power on" but since it involves movement at speeds at or near those of flight it seems better to put it under "power on."

Considering now the characteristics that are of interest in each of these maneuvers they may be defined as follows:

Strength. The ability to support the static and dynamic loads resulting from hydrostatic, aerodynamic, and hydrodynamic forces in general and in detail. This includes the strength of the hull as a whole and the local strength required to resist the various impact loads such as those from porpoising or landing.

Stability. The ability to maintain a proper attitude afloat under any maneuver. This includes the provision of adequate restoring moments when heeled or pitched to keep the craft from rolling too far or from burying the bow or stern.

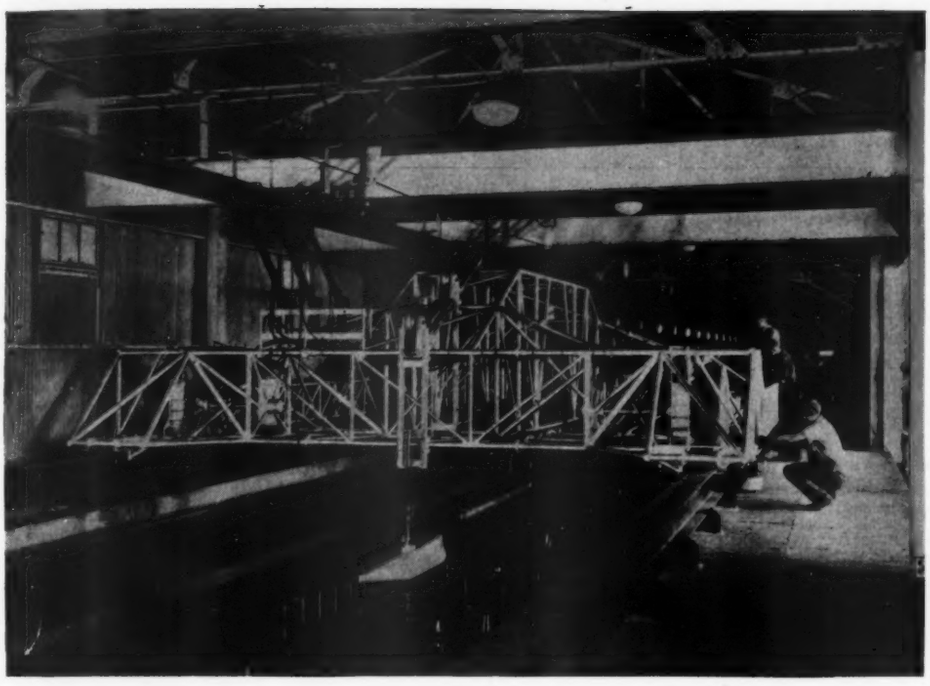
Controllability. The ability to hold a proper course or attitude relative to sea or wind direction without excessive effort on the part of the pilot. The ability to change the course or attitude as easily is implied.

Seakindliness. This is a term borrowed from the naval architects and is intended to define a characteristic manifested by easy motion without violent pitching or rolling. The craft moves as though in harmony with the external forces, without evidence of disturbance or conflict, and yet retains full stability and controllability. Yachtsmen will recognize the characteristic that differentiates between a purely seaworthy boat and a good seaboat.

Resistance and Propulsion hardly need defining but in this case the resistance to motion through or over the water which is produced by the different disturbances that accompany such motion is intended. Likewise under propulsion should be included those special conditions introduced into the problem of obtaining adequate thrust and proper efficiency of propulsion on the water by the fact that the craft is a flying boat.

It is obvious that these same characteristics, with others, might be investigated in connection with maneuvers in the air. That side of the general problem will not be considered, however, beyond calling attention to the fact that, when the aerodynamic characteristics of the craft are considered, the air resistance of the hull will be given special study and a further compromise may be necessary between the demand of conditions on the water and in the air.

The relative importance of the various characteristics will be influenced by the purpose behind the design. If the craft is to be a true "flying ship" able to alight on the water and remain there in safety for long periods the emphasis on the respective characteristics will be quite different from what it would be if the flotation provided by the hull is assumed to last only until a rescue ship arrives. It is clear that in one case the strength, stability, and seakindliness are of major interest while in the other they are of considerably less interest and strength while taking off and landing will practically determine the scantlings of the hull.



The N.A.C.A. towing tank provides a run of 2,000 ft. and a speed range of 4 to 58 m.p.h.

The table below was developed to make clear the fields in which research should be done. It can also be used as a key to show how much help the designer should expect from the tank at present and what further help he may obtain later on. The word "tank" should be understood to include the whole body of experimental towing basins, not any particular one. The various items will be taken up again in the same order.

At present the tank can give no assistance to the designer regarding the strength of the hull of a flying boat. The control surface moments may be derived with the help of the trimming moments obtained in a take-off test but this does not cover the larger problems of general and special strengths. Such problems must be solved by the aid of experience and the methods of the naval architect. Wave profiles for hogging and sagging conditions must be selected and the bending moments computed as done in the case of ships. Intense local loads, such as those produced by the pounding of the bow during take-off or the impacts of landing or porpoising must be estimated from experience with existing craft and the small amount of full size data on bottom pressures. There is much room for differences of opinion and practice. In the future it should be possible to refer to reports on extensive series of tests to determine the impact and pressure loads on full size craft. Equipment for this seems to be within the realm of construction possibility now.

Paralleling these tests there might well be tests made in the tank on models dropped in various manners to simulate landing and porpoising to learn how the model tests are related to the full size tests. It might even be possible to simulate waves on a proper scale and determine the pressure effects on models in various maneuvers. After full correlation of model and full size tests the loads on a new design might be predicted with considerable accuracy.

The static stability of a flying boat on the water is a matter of computation. The method has been worked out for ships and would present no difficulties were it not for the irregular forms involved as a result of the presence of steps. At present it is possible to replace the computation by inclining and trimming experiments on the models intended for use in towing tests.

When we approach dynamic stability we encounter many difficulties and at present the tank can give no direct help in avoiding them. In the course of a test for resistance a watch may be kept for the appearance of porpoising but neither its absence nor its presence in the model test is conclusive.

A mathematical theory of porpoising has been developed in England but no correlation exists between the theory and either full size or model tests. A promising field for study would seem to be the development of elemental models to be used in checking the theory while at the same time an attempt was made to find the conditions under which models of the usual form would porpoise. Proceeding from these to model tests to determine the magnitudes of the quantities required to enable a prediction of porpoising characteristics would seem natural. Unfortunately, it is a complex phenomenon in which both aerodynamic and hydrodynamic forces play a part together with the inertia forces. Just how far such an investigation may go cannot be forecast. From what is known it is believed that eventually porpoising will be put on the same footing as other hydrodynamic phenomena and will become a matter of coefficients.

At present the tank is equipped to give no information regarding controllability. Towing models at an angle of yaw has been done in Germany but what use has been made of the data we do not know. Arrangements to make towing in yaw possible are not difficult technically. If this sort of test should prove to have a value in determining controllability on the water it would seem probable that designers could expect such data.

Seakindliness has an elusive character but obviously results from a harmonious synthesis of all the other elements. At present the tank can give no criterion for this characteristic. Observa-

	Maneuvers				
	On Water				In Air
	Power Off			Power On	
Characteristics	Anchored	Drifting	Taxiing	Taking Off	Landing
Strength					
Stability					
Controllability					
Seakindliness					
Resistance and Propulsion					

tion of the models being towed and experience in correlating model characteristics and full size performance may lead to better information. It is difficult to see how any specific test can be devised. One would rather expect a conclusion drawn from good results of other tests.

At present the tank can speak with some authority on resistance. It was the first characteristic that was investigated and the investigators had at their disposal an accumulation of years in testing ship models. Such models, however, were quite different in their behavior from the models of seaplane floats and flying boat hulls and a new technique in testing has resulted.

It is now possible to test models for the purpose of determining resistance, trim, trim moment at fixed trims, and rise, and to feel quite confident that the test simulates the behavior of the full size so closely that the results may be converted to full size with assurance of their reasonable accuracy. Much time may be spent in arguing regarding the correctness or incorrectness of converting the whole of the observed resistance according to Froude's rule for wave making resistance and neglecting the frictional or viscous resistance. There seems no doubt that at high speeds a large part of the trial resistance is viscous or frictional but the conversion would follow Froude's rule so nearly as to make little practical difference.

In connection with resistance and its associated phenomena there remain the perennial questions of best form for the hull generally and for the step. These and dozens of like questions can be dealt with by existing methods and equipment. It is simply a matter of time.

Looking forward to that happy time when most of these hopes may be realities we may contrast the help the designer of a large flying boat may expect from the tank in that day with what he may be able to obtain today. Then he may expect quite definite data to be available, from full scale tests already made, regarding the impact loads on hulls in all maneuvers. He may expect that the tank will be able to investigate, at least in part, the impact loads on his particular design. Any tendency of his design to porpoise can be predicted with accuracy and the measures required to cure it can be indicated. The general stability can be completely investigated if necessary. At least some information can be given regarding the controllability of the craft on the water. From all the test data at least an approximate figure of merit as to seakindliness can be given.

The resistance can be given with greater accuracy than at present and the computations of time of take-off and getaway run will be correspondingly more accurate. Pilots may be given a schedule of time angles to follow during take-off as a result of the tank tests.

Looking back at some early flying boats of large size, and remembering the uncertainties then obtaining, makes one appreciative of the difficulties those designers overcame. At the same time it adds confidence to the belief that even after many of our present major problems are solved, there will still be some difficulties to worry designers and the tank will have to devise new methods with which to help in attacking them.

A British Note on Noise Reduction

IN the February (1933) issue of AVIATION an abstract of an article published in the *Journal of the Royal Aeronautical Society* by A. H. Davis, D.Sc., physicist of the National Physical Laboratory (England) covered the results of research on the problem of noise in aircraft. A report on a continuation of the same study by the same author has been issued by the British Air Ministry under the title, "Silencing Aircraft" (Aeronautical Research Committee Reports and Memoranda No. 1542).

The research follows two general lines; first, a laboratory determination of the intensity of sound at the source (engine and propeller noises, etc.), combined with a laboratory determination of the insulating values of various types of cabin wall from which the intensity of sound within airplane cabins could be estimated by subtraction; and, second, by direct sound measurements inside airplane cabins in flight. Of the eight transport airplanes studied, the results obtained by the two methods were remarkably consistent, there being only one example where the calculated and measured values were in violent disagreement.

From the laboratory results, a tentative scale of loudness of noises as heard in an airplane cabin (assuming the walls to be removed) is shown in Table 1. The sound deadening effects of various types of cabin wall construction, also derived from laboratory results, are indicated in Table 2.

The actual sound intensities (measured in points in the cabin behind the plane of the propeller) for several typical British transports are of some interest for comparison with cabin conditions in American planes. An early DeHaviland three-engined transport (20 passengers) showed 95 decibels with ungeared engines and 87 decibels with geared engines. The latest type 40-passenger DeHaviland machine (Heracles Class) with four geared engines shows only 73 decibels. In the latter case, the Alclad outer skin was backed up with 1¼ in. Kapok with an inner skin of plywood and cloth. One of the quietest machines measured was the 17-place Short "Valeta" flying boat with three geared engines. With dural outer skin, Kapok blanket and cloth cabin lining, the measured intensity was 71 decibels. These figures compare very favorably with values on recent American designs.

TABLE 1
Tentative scale of loudness of noises as heard in cabin with walls absent

Source	Loudness (db. above zero on scale).	
Engine Clatter: (Engines of about, say 400 hp.)	100 db. at 8 ft. (air-cooled engines). 95 db. at 14 ft.	
Exhaust Noise: (Engines of about 400 hp.)	100 db. at 10 ft. (perforated silencer).	
Propeller Noise: For tip speeds as given below.	In plane of propeller at 8 ft. from center.*	45 deg. behind plane of propeller at 14 ft. from center.
ft. per sec.		
650	100	95
750	110	100
850	120	105

*Test bench figures at 80 ft. somewhat behind planes were 20 db. below these. (The allowance for distance on an inverse square law would be 20 db.)

TABLE 2
Reductions of loudness due to cabin walls

Approximate weight of cabin wall.* lb./sq.ft.	Reduction of loudness of noise by cabin wall.	
	Single panels. (db.)	Filled double panels. (db.)
⅛	5 (fabric)	—
¼	10 (rexine)	—
½	15 (0.02 in. Al)	—
¾	20 (¼-in. plywood)	21†
1	22	27‡
1½	25	31‡
2	30	—

*This is the total weight of the wall, including struts, and only part of it can be attributed to lagging material. Two-inch Kapok blankets weigh only about 0.2-0.4 lb. per sq.ft. Four layers of ¼-inch Kapok give a weight of 0.2 lb. per sq.ft. and are as good as one layer of 2-in. Kapok.

†Outer skin of fabric, filler of 2-in. Kapok blanket, and inner lining of Micarta.

‡Outer skin of 0.025 aluminum, filler of 2-in. Kapok blanket, and inner linings of Micarta or insulite.

The fifth article of the series on operation at desired cruising conditions is a direct continuation of the fourth in which the first of two methods of power determination was outlined. In the present paper the second of these processes, in which propeller calibration is used, is described in detail with an illustrative example. This and other articles of the present series are based on the extensive test flights made by the authors on the Douglas DC-1 transport.

Power Determination for Cruising Operation

By Edmund T. Allen and W. Bailey Oswald

THE PROCESS of power determination in flight by the use of two types of engine calibration curves has been treated in detail in the previous article and an alternative method was mentioned. The second system of procedure to obtain the power-required history of the airplane in cruising flight is that of propeller calibration. The principle of this method lies basically in the fact that the power coefficient, C_P, of the propeller at a given setting in level flight depends on the advance ratio $\frac{v}{nD}$ (velocity divided by the product of the revolutions and diameter). Curves of this relationship, as plotted in Figs. 15, 16 and 17, are referred to as the propeller calibration curves. The engine power absorbed by the propeller operating at a given advance ratio is then given by the product of the power coefficient, relative density, engine revolutions cubed, and the fifth power of the diameter. For a given propeller the diameter may be included in the constants and the results applied more directly as in Fig. 17. This method is particularly useful when engine calibration curves are available at only one altitude. For the calibration it is required only that engine power be known at any one altitude with respect to engine revolutions and intake manifold pressure, such as shown on the left hand side of Fig. 12. These necessary engine data are almost always obtainable and are often more reliable than the altitude engine calibration curves.

The propeller calibration method can be used as a check against the engine calibration curve method previously described. From certain considerations propeller calibration is the preferred method even though complete engine data are available. Power determined from propeller characteristics is independent of the engine installation and mechanical condition of the engine since, for level flight, it depends on the atmospheric conditions, velocity of flight, and engine revolutions only.

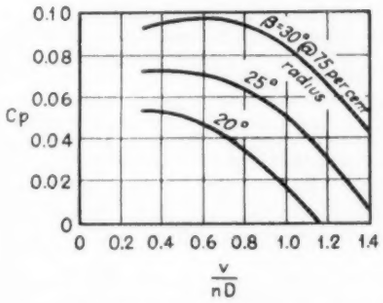


Fig. 15: Variation of propeller power coefficient with advance ratio, showing the effect of various blade angle settings. (From data in N.A.C.A. Technical Report No. 306)

The propeller itself is an instrument which can be used to the fullest extent in obtaining much useful information regarding power in addition to the usually desired power-altitude relations for the cruising condition. Once the propeller calibration is obtained the engine characteristics at any other altitude can be checked, thus a check on the expected power at other than rated conditions is possible. Such a propeller calibration has somewhat the significance and use of an airspeed meter calibration, becoming an inherent characteristic of the airplane as a whole.

If carefully planned an entire calibration can be obtained in about one hour and reductions to the calibration charts made in like time. For any type of airplane intended for transport or military operation such a test should be well justified. In fact, it would be highly desirable to calibrate the propeller for a series of blade angles, so that the effects and benefits accruing from any blade setting might be weighed and the proper setting chosen with full knowledge of the power characteristics in flight.

A fruitful field for the application of the propeller calibration method of power determination is that of obtaining the variation of full throttle and throttled engine power with altitude. Many testing agencies have reliable calibrations on engines now installed in airplanes. After a propeller calibration is made under the known engine calibration conditions, the entire power altitude characteristics of the engine can be obtained by subsequent flights. A series of such tests should lead to data of almost incalculable value relating to the actual operation of engines in flight, under varying conditions of mixture control, carburetor heat, ram, back pressure, humidity, temperature, etc.

Principles of propeller calibration

The principle of the propeller calibration is based on the generally accepted aerodynamic relation that the power coefficient of a propeller depends on the rate of advance ratio $\frac{v}{nD}$, the blade angle β, and the angle of attack of the thrust axis α, which can be expressed mathematically as follows:

$$(1)\quad C_P = f\left(\frac{v}{nD}, \beta, \alpha\right)$$

where:

C_P = power coefficient
$\frac{v}{nD}$ = rate of advance ratio
v = velocity of airplane (ft. per sec.)
n = revolutions of propeller per second
D = propeller diameter (ft.)
α = angle of thrust axis to direction of flight
β = propeller blade angle setting (preferably at .75 radius)

By dimensional analysis,

$$(2)\quad C_P = \frac{550P}{\rho n^3 D^5}$$

where:
P = developed engine horsepower
ρ = air density slugs / cu.ft.

Figs. 15 and 16 show the general type of variation of the power coefficient, the advance ratio, blade angle setting, and angle of thrust axis to direction of flight. Weight changes will cause relatively small changes in the latter. Moreover Fig. 16 shows that while the advance ratio remains fixed, the power coefficient is practically constant for any change in this factor reasonably to be expected as a result of weight change. Therefore for purposes of power determination we may write the mathematical relationship,

$$(3)\ C_P = F\left(\frac{v}{nD}\right) \text{ for a given blade angle } \beta.$$

For engineering purposes it is often preferable to define the coefficients as,

$$(4)\ K_P = \frac{b.hp.}{\sigma\left(\frac{r.p.m.}{100}\right)^3} = \text{power factor}$$

and,

$$(5)\ J_P = \frac{m.p.h.}{\left(\frac{r.p.m.}{100}\right)} = \text{advance ratio factor}$$

thus including the various constants for reduction to absolute coefficients in the engineering factors. Fig. 17 shows the results of a flight test propeller calibration plotted with respect to these factors.

The propeller calibration forms a method of good accuracy for obtaining the power-altitude-velocity characteristics of the airplane. For the constant weight condition the propeller characteristics in level flight are exactly constant with fixed advance ratio at all altitudes. Blade twist and deflection are unchanged since the thrust, moment, and angle of attack of the blade are constant. With considerable weight change the power coefficient shows little change for the probable variation in angle of attack. Such propeller calibration becomes a valuable inherent part of the airplane.

It is interesting to note that the mechanical efficiency of the engine can be checked from time to time by a propeller calibration. If a calibration based on the engine curves produces a curve lying above the correct curve, the results indicate that actual power developed is lower than calibration curve power. Likewise when increased manifold pressure is required for a given velocity and engine revolutions above that shown on the cruising chart, it is known that the mechanical efficiency of the engine has decreased.

A similar but somewhat more complex treatment of power determination can be applied to the climbing and gliding conditions of flight. The technique of obtaining the calibration in level flight and application to power determination at various level flight speeds is given briefly below. The construction of cruising charts derived from these results and their application to transport operation will be discussed in subsequent articles.

Flight Test Technique

The procedure regarding calibration, installation, and number of instruments is exactly the same as the method previously described under "Flight Test Technique" on the "Engine Power Calibration Curve" method of power determination. The six principal (1 to 6) and five supplementary (7 to 11) recorded items tabulated below are necessary and sufficient as before:

1. Indicated velocity.
2. Atmospheric temperature.
3. Pressure altitude, or absolute pressure of the atmosphere.
4. Carburetor air intake temperature.
5. Absolute intake manifold pressure.
6. Engine revolutions.
7. Airplane weight (approx.).
8. Exhaust back pressure.
9. Wet and dry bulb readings.
10. Mixture control.
11. Head temperature, etc.

The most important instrument for the propeller calibration method is the engine tachometer. Since power depends on the propeller revolutions cubed, the greatest accuracy must be obtainable in the readings of propeller (or engine) revolutions. Tachometers must be calibrated with greatest care and read to $\frac{1}{8}$ of 1 per cent in tests for determining power within an accuracy of 1 per cent, which is recommended for satisfactory results.

The first flight test consists of the calibration of the propeller. The airplane is flown in level flight at the altitude for which the engine calibration curves are available. If engine data are available at various altitudes the calibration should be made at the altitude at which it is believed the data are most accurate. The airplane is flown level at several speeds from maximum to that just above the stall, and the items previously listed are recorded at each speed after sufficient time has been allowed for conditions to stabilize. Since points thus obtained often cover only a short length of the curve it is recommended that several points in climbing and gliding flight be taken, thus extending the curve and more definitely establishing its shape, though the latter points should be regarded as establishing the trend of the curve rather than as actual points necessarily lying on the level flight curve.

The relative density is derived from items 2 and 3 in the usual manner. Velocity is calculated from recorded

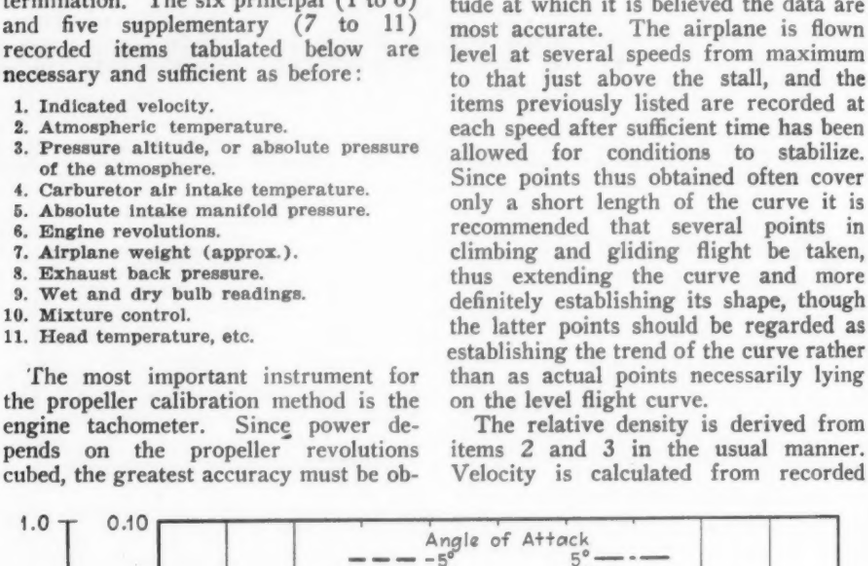


Fig. 16: Propeller coefficients of power and thrust and propulsive efficiency as functions of the advance ratio. These curves illustrate the small effect of comparatively large changes in angle of thrust axis upon the power coefficient even though the thrust coefficient and propulsive efficiency are considerably changed. (From data in N.A.C.A. Technical Report No. 415)

items 1 to 3 and the airspeed meter curve of Fig. 14. Engine power is obtained from items 3 to 6 and engine curves such as drawn on the left side of Fig. 12. The factors K_P and J_P are then calculated according to equations 4 and 5. The results form the propeller calibration curve shown in Fig. 17.

Subsequent tests are then made for determining the power at various speeds at other altitudes. All data are obtained and recorded as for preceding tests. The engine power developed at each observation is then derived as follows:

1. Obtain relative density.
2. Calculate true velocity, m.p.h.
3. Calculate factor $J_P = \frac{m.p.h.}{\left(\frac{\text{r.p.m.}}{100}\right)}$
4. Look up power factor K_P from propeller calibration curve.
5. Calculate developed power according to the equation,
6. $P = K_P \sigma \left(\frac{r.p.m.}{100}\right)^3$

For multi-engine airplanes the average values of the engine instrument readings are used. The readings for engine revolutions should be approximately the same for the various engines since it is possible to synchronize them very closely by ear. Any considerable discrepancy in readings is indicative of inaccurate tachometer readings. Synchronization rather than equal tachometer readings is recommended for control of engine revolutions on multi-engine airplanes. Other instrument readings may vary considerably between engines, however, since manifold pressures and carburetor air temperatures may not necessarily be equal.

The humidity of the atmosphere can be neglected except at the lower altitudes when the relative humidity is high. In this case the intake manifold pressure used in obtaining engine power from the engine curves is the partial pressure of the dry air only. The relative density is reduced by increasing humidity according to the mathematical relationship:

7. $\sigma = \sigma\,(\text{dry air})\left(1 - 0.378\frac{e}{p}\right)$

where: e = vapor pressure
p = total atmospheric pressure

These two alternate methods of power determination in co-ordination with flight tests covering the entire region of cruising operation enable the complete determination of power, manifold pressure, and engine revolutions for each speed and altitude of flight. Cruising performance for maximum and normal cruising power limits is thus explicitly shown. The general types of cruising curves obtained have been shown in a preceding article (AVIATION, May, 1934). The construction of cruising charts from these test data and the application to various types of airplanes will be treated in future articles.

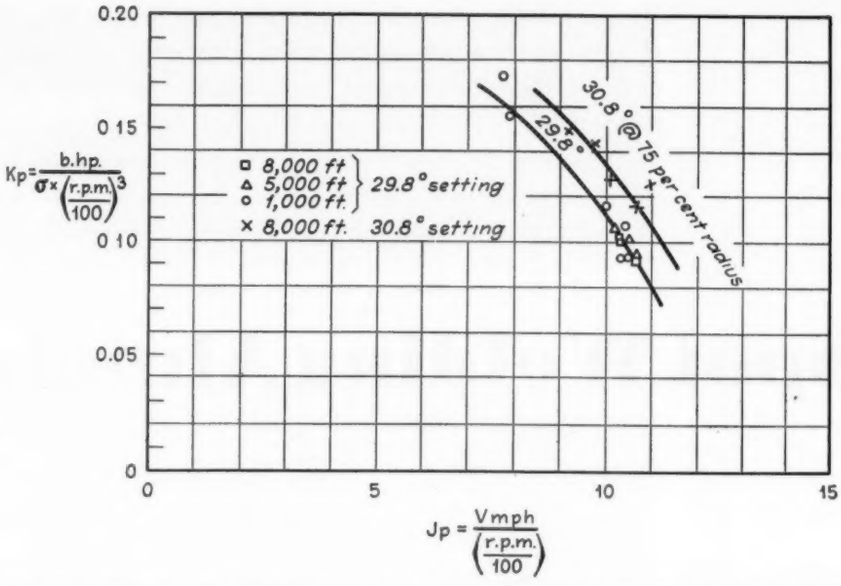


Fig. 17. Propeller calibration curve for three bladed, 11.5 ft. diameter Hamilton Standard controllable pitch propeller on the Douglas DC-1. Results for two high pitch settings are shown. Points from calibrations at various altitudes are included.

Illustrative example. To find the brake horsepower absorbed by the propeller in cruising level flight on the DC-1 with 30.8 deg. pitch setting from the following flight test data:

Altitude .....10,000 ft.
Atmospheric temperature ....50 deg. F.
R.P.M. 1,800
True airspeed.....190 m.p.h.

First reduce the atmospheric conditions to $\sigma = 0.7$ from any convenient atmospheric chart and then we find the rate of advance ratio on the J_P scale above = 10.5. Reading off the power coefficient for $J_P = 10.5$ and pitch equal to 30.8 deg., we get $K_P = 0.122$. Horsepower absorbed is then obtained from the relation b.hp. $= K_P \times \sigma \times \left(\frac{\text{r.p.m.}}{100}\right)^3 = .122 \times .7 \times 5832 =$ 497 b.hp. per engine, or 70 per cent of rated power.

A comparison with the other method of power determination from engine data described in the preceding article may be of interest.

●

M. I. T. Fog Experiments

ACCORDING to legend, there are more ways than one of killing a cat. Clearly, too, there should be more than one way of attacking the problem of landing an airplane safely in fog. Most of the solutions so far proposed or tried have been based on the premise that the fog is inevitably present, and have involved the development of instruments to substitute for the actual pilot's-eye view of the ground. With a David-like faith that the Goliath Fog may be brought to earth by the proper placement of a few small missiles, researchers from the Massachusetts Institute of Technology experimenting at Colonel Green's Round Hill Airport have apparently exploded the theory of inevitability.

For several years Henry G. Houghton, Jr., a member of the Institute's staff, has been making a study of the physical make-up of fog particles. He observed their behavior in glass walled chambers, measured them, coated them with various chemicals until he found something that would make the tiny droplets (some of them less than 1/25,000 in. in diameter) coalesce and precipitate out of the air. What that "something" is so far remains a secret, but what it can do was dramatically demonstrated at Round Hill.

The apparatus used consists of a pipe 100 ft. long suspended horizontally on a wire rope catenary about 30 ft. from the ground. A large number of specially designed nozzles protrude at odd angles from the pipe along its length. When the chemical solution is sprayed into the air a curtain of finely divided material is formed that condenses the water vapor and carries it to the ground by force of gravity. Its chief virtue is that it seems to work. On July 20, with visibility less than 500 ft. and with fog drifting in from Buzzards Bay on a 13 m.p.h. wind the pumps were started. Almost at once a path approximately 100 ft. wide and 30 ft. high began to clear through the solid fog. In a few minutes objects 2,000 ft. away on the opposite side of the field came clearly into view. The path remained clear until some minutes after the pumps had been shut down.

Whether or not the method can be applied economically to large areas remains to be seen. It will also be necessary to try it out under many other conditions of wind and fog density, but at least it points to another possible solution for one of aviation's worst problems.

Because of the attractive production possibilities in spot welding as a method of fabrication of aluminum alloys, the efforts of metallurgists and electrical engineers have been united in the solution of problems arising in the development of technique and in the design of welding equipment capable of producing the necessary consistency of results. Both the metallurgical and the electrical considerations are discussed in this the second of three articles by members of the technical staff of the Aluminum Company of America.

Spot Welding Aluminum Alloys

By D. I. Bohn

Aluminum Company of America

RIVETING long has been the basis of aircraft structural fabrication, and the properties of riveted joints are now well known. There is reason to believe, however, that resistance welding, both spot and seam may eventually replace a great many rivets used at present. Such methods of welding have been developed to a point where the consistency of results appears to be entirely satisfactory, and undoubtedly these methods will expand rapidly for aircraft fabrication, but it must be kept in mind that the metallurgical, electrical and thermal characteristics of aluminum alloys make necessary a considerably different type of equipment and technique as compared with those used for most other metals.

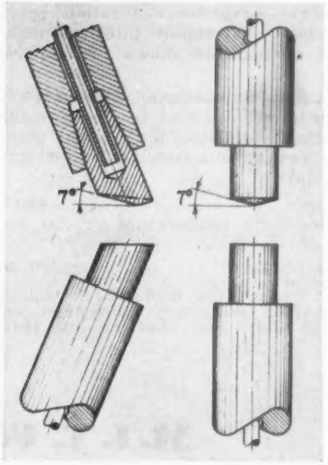
A good spot weld between sheets of any of the aluminum alloys is based on the formation of a molten spheroid between the sheets, with the melting intensely localized so that the outer surfaces are practically unaffected. This requires precision control of all variables entering into the process.

The relatively high electrical conductivity of the aluminum alloys demands that the spot or seam welder supply a much greater amperage than is necessary to weld most other materials. It also is highly desirable that the design of the moving electrode be carried out with a view toward eliminating inertia as much as possible to avoid an undesirable hammer blow.

For these reasons, a great deal of the development work has involved the designing of suitable equipment to provide for such desirable features. As a result, there are available on the market designs of spot and seam welders which are practically ideal for handling the aluminum alloys.

Timing control vital

The most vital single feature of the process concerns the control of the power supply. Standardized machines used for other materials usually do not require anything other than fairly accurate, non-synchronous timing of the power input to the welder. Errors in timing of two or three cycles do not greatly affect the results, as the duration of power application is relatively long, and variations of this order have little effect on the consistency of the weld.



Conical tips have been found to be most satisfactory for the welding electrodes.

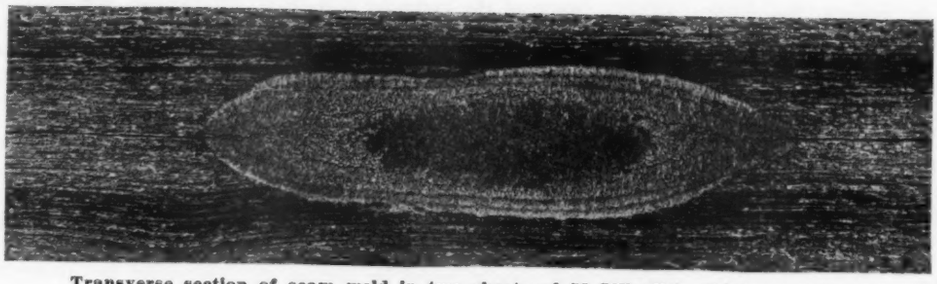
In order to obtain the high thermal gradient necessary for proper spot or seam welding of the aluminum alloys, however, short power applications are required, the values in general extending from ½ cycle (assuming a 60-cycle power supply) to 6 or 8 cycles maximum for the gages of material used in aircraft. An excessive period of current flow permits the molten zone to extend close to the outer surface of the sheet, and, besides causing extra electrode maintenance, fails to provide maximum spot strength. Conversely, too short a period of flow will result in the formation of such a shallow molten zone that the strength is again unsatisfactory. Sufficient experimental work has been carried on so that the proper number of cycles for any gage has been predetermined, and experimenting with this factor has been eliminated. The assumption is, of course, that the timing equipment will deliver synchronously timed impulses of power of the desired number of cycles without variation in successive spot welds. Fortunately the rapid advance in the art of electronics has provided commercial equipment which will answer these specifications.

Equipment rating and design

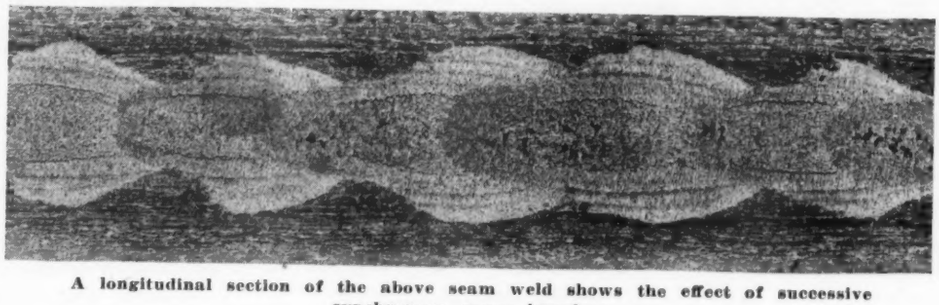
The electrical rating of most resistance welding equipment is usually expressed in kilovolt-amperes. This is based on a nominal rating of the transformer supplying the welding current. The maximum gage of material which a given machine will spot weld satisfactorily is based on only one factor—welding amperes. This amperage depends on the design of the machine and is practically independent of the work between the electrodes.

The rating in kilovolt-amperes as applied to welding machinery is the product of open circuit secondary volts and welding amperes. The actual consumption of kilovolt-amperes for certain weld may be more than the nominal rating of the transformer, or less. The open circuit voltage is a design feature which should be selected to provide the desired welding amperes and, in itself, has nothing to do with the actual making of the weld.

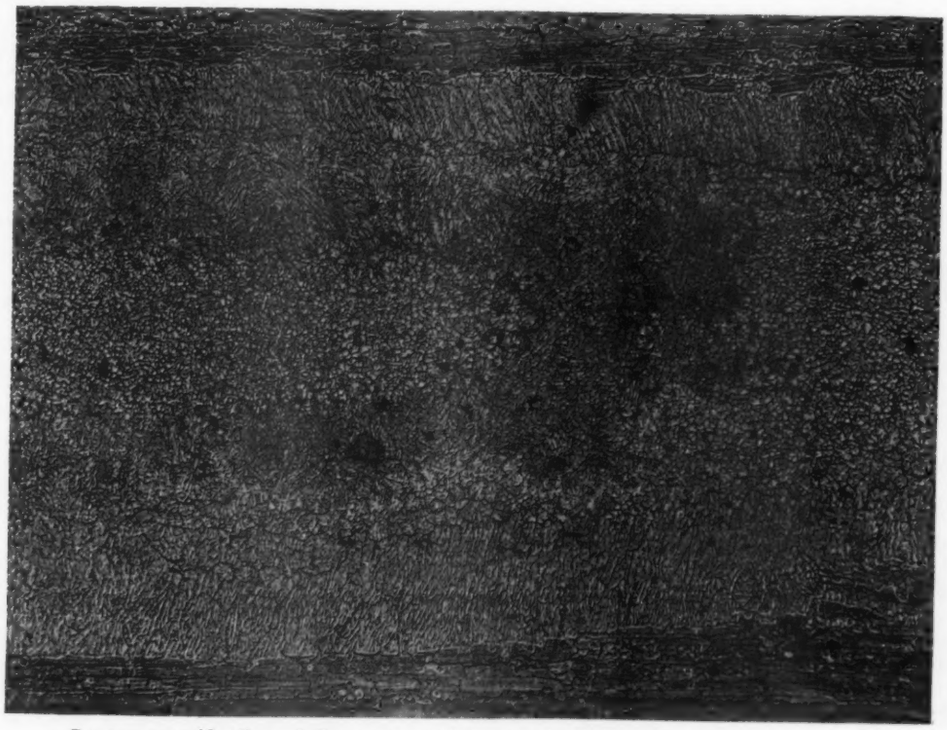
Assume, for instance, that a certain machine has a 10-volt open circuit secondary rating. When the weld current is flowing, the 10 volts is absorbed in various reactive drops throughout the secondary circuit. If the machine is designed to provide 30,000 amperes maximum, there may be 3 volts drop in the transformer secondary voltage, indicating that the transformer reactance has absorbed 90 kva. The flexibles to the



Transverse section of seam weld in two sheets of 53-SW alloy, thickness .051 in. This is typical of a spot weld in the strong aluminum alloys.



A longitudinal section of the above seam weld shows the effect of successive synchronous power impulses.



Larger magnification of the upper photograph illustrates the change of structure from the center of the spot toward the unaffected outer metal.

upper arm may consume ½ volt, or 15 kva. Each of the two arms may absorb 2½ volts, or a total of 150 kva. The electrodes and holders themselves may absorb the last 1½ volts, or 45 kva.

This gives a total of 300 kva., which corresponds with the initial open circuit voltage of 10, multiplied by the 30,000 welding amperes, indicating that no kilovolt-amperes are used in making the weld proper. This is not strictly the case, but is practically so from a design standpoint, as the voltage drop through the weld material is practically all resistance drop and has no appreciable effect on the design figures which may be based entirely on the reactance involved. Nearly all of these values are fairly closely computable and permit a machine design to be handled in the same way as any other electrical circuit problem.

From the above, it will be seen readily that an increase in throat length increases the kilovolt-amperes by requiring a higher secondary voltage to provide the same welding amperes. With the above designed machine, for instance, if the throat length is doubled, an additional 5 volts will be necessary to provide for the extra reactive drop in the two arms, making the necessary open circuit voltage 15 instead of 10. This alone will increase the kilovolt-amperes required by 50 per cent, and also would indicate a larger rating of

the transformer to reduce the kilovolt-amperes absorbed in transformer reactance.

All of the above considerations apply to either spot or seam welders. In spot welding, however, the electrodes play an important part in providing consistent results, and this has resulted in studies being made of a number of different types.

Electrode design

As is often the case, the simplest design may be the best, and this seems to have worked out with respect to electrode design. A conically shaped tip, made as shown in Fig. 1, has been very satisfactory for all gages of material. This tip provides an initial low area of pressure to cause early melting. As the weld progresses and the molten zone grows in size, the conical contour of the electrode will permit it to sink into the surface of the material to a greater extent, decreasing the current density. This feature alone provides a certain measure of stability to compensate for other minor unavoidable variations and has resulted in more consistent spot strengths than flat or curved electrodes provide.

By using one of the hard copper alloys, such as are available for this purpose, the conical contour will not be altered appreciably for several hundred spots. It is essential, of course, that water cooling be provided inside of the tip, as otherwise it will reach such a high temperature that its hardness will be lost.

Tips never should be dressed up with a file. The slight aluminum alloying which may occur may be removed at intervals with a piece of fine emery or sandpaper, held in the fingers, and when the tip contour has been altered appreciably, it should be removed and a newly machined one inserted. By having a number of tips on hand, which may be machined in a small lathe very quickly, the problem of tip maintenance becomes of secondary importance.

Spot welds between two sheets will normally use two of the conical tips. It is possible to obtain practically as good results using one flat tip and one conical tip, although the molten zone is slightly off-center due to the conical current distribution through the sheets. This does not affect the strength appreciably and is oftentimes desirable where it is necessary to have the spots practically invisible on one of the outer surfaces.

Welding pressures

Any form of pressure mechanism which is conveniently adjusted, and will not vary when once adjusted, is suitable. Electrode pressures used will vary from a few hundred pounds for the thinner gages to about 1,000 lb. for material of $\frac{1}{16}$ in. or $\frac{1}{8}$ in. thickness. This refers to the strong aluminum alloys. Some of the common non-heat-treatable alloys, particularly in the annealed temper, have a lower yield point, and lower pressure must be used. A pneumatic cylinder fed from a small reservoir, whose pressure is controlled by a reducing valve, has been found to be very satisfactory for providing electrode pressure. Its use also permits the machine to be designed so that the open electrode distance may be varied quickly and conveniently by means of a hand crank,—a very convenient feature, permitting a minimum stroke to be used, with consequent reduction in hammer blow.

Surface conditions

Surface conditions play an important part in the spot and seam welding of alloys. All aluminum alloys have an oxide surface whose resistance is considerably greater than that of the metal itself. With most of the common alloys, the oxide film is of sufficient resistivity to permit a proper weld and yet not cause excessive heating where they contact the electrodes. In most cases, the common alloys do not require that the surfaces be cleaned or otherwise treated prior to spot welding.

Practically all of the strong, heat-treated aircraft alloys have a much higher resistance surface than is present on the common alloys. This nearly always demands that the outer surfaces contacting the electrodes be cleaned by sandpapering, or the equivalent, in order to prevent undesirable heating at such points. It is sometimes preferable to clean one of the internal surfaces.

These statements do not apply to the Alclad material, whose surface characteristics are entirely suitable without any treatment or cleaning.

Spot vs. seam welding

There is no basic difference between spot and seam welding. Spot welding is an intermittent process, each spot being initiated by the operator, whereas in seam welding, rollers are substituted for electrodes and the process is entirely continuous and automatic. The same considerations with respect to synchronous timing of power, pressure, and surface conditions apply as with spot welding.

Although continuous seams may be made in any of the alloys, the particular field lies in the common alloys because of the greater ductility present with welds in the latter.

Seam welds may be classified in two groups, viz., continuous and intermittent. The continuous seam is formed by adjusting the electrical control equipment to provide successive shots of synchronous power, so timed that, in conjunction with the electrode wheel speed, the successively formed spots overlap.

In order to provide the proper proportion of molten zone thickness to sheet thickness, the percentage of the time during which power must be applied should not, in general, exceed 25 per cent. In many cases, percentages considerably less than this have been used with success. One adjustment which has been used with .064-in. thick sheet of one of the common alloys has been 2 cycles on, 7 cycles off, with a wheel speed of $3\frac{1}{2}$ ft. per minute. If sufficient power is available, this speed may be increased by going to 1 cycle on and 4 off.

By altering the electrical adjustments and speed, it is evident that the successive impulses of power may be made so that the spots formed do not overlap. Such an adjustment might be made which will provide spots spaced $\frac{1}{4}$ in. apart, simulating a spot weld. The speed will be much greater, and where this process can be used, it will be considerably cheaper and faster than spot welding. It is expected that the use of a seam welder for providing intermittent spots in this manner will be just as important, if not more so, as for making continuous seams for gas or liquid-tight containers.

Consistency of results is the best criterion of the value of any spot or seam weld process. With equipment fulfilling the conditions described, spot and seam weld strengths should vary but little from the average, normally lying between the 90 per cent and 110 per cent range of average strengths. Fatigue results, while by no means complete, have been likewise consistent and comparable with those obtained on riveted joints.

Corrosion protection

With respect to corrosion protection, two general methods are in common use. One of these consists in anodizing the material before assembly and painting for further protection. The other consists in the use of the Alclad materials, either entirely unprotected or painted for appearance.

Anodizing produces an insulating film on the surface of the material, precluding the use of spot welding material treated in this manner. For this reason, any spot or seam welded structure would, of necessity, have to be anodized after fabrication. Obviously, anodizing at this time is indeterminate with respect to the protection which it will afford in between a spot or seam welded joint of lapped sheets and would indicate that the use of spot welding and Alclad materials will go hand in hand.

Quite extensive salt spray corrosion tests on spot welded Alclad joints indicate no observable loss of strength in the spots. This is what would be expected as the electrolytic protection which Alclad offers for rivet heads, sheet edges, etc., also is present to protect any exposed alloy surface resulting from the formation of a spot weld.

EDITORIALS

AVIATION

World Air Routes

THE SUN never sets on air transport. Ten years ago the aviation map of the world comprised a government-operated route in the United States, a few dozen short lines in Europe and a couple of spurs tentatively feeling their way from France down into northern Africa, and the nucleus of a service running along the Magdalena River in Colombia. Within that brief space of time the national networks have become international, and then have spread out, touched each other, and been tied together until there is scarcely a country in the world except Ethiopia and Afghanistan that fails to boast of airline ticket offices parcelling out transportation to the remote parts of the earth. You can buy airline tickets in kroner or lei or pesetas or yen or drachmas or zlotys. Air transportation is no longer either national or imperial. It is circumnavigational. The world is its oyster, and perhaps it is appropriate that we recognize the fact in a special issue of AVIATION just ten years from the time of the first world-girdling flight by a U. S. Army squadron.

SCIENTIFIC development and the applications of science to industry sometimes progress by a sort of leap-frog. When new and improved production machinery is put on the market it is less likely to be bought by the fellow who just re-equipped his plant three or four years ago than by the one whose tools are already fifteen or twenty years old and who has begun to think seriously about the prospect of his present equipment falling to pieces in any case. In a similar fashion a new idea gains most rapid acceptance where it has no competition. Thus air transport has received its quickest welcome and had at once its most eager and its most tolerant audience in the countries where, practically speaking, there was no other transportation of any kind. Important though commercial aviation is to the United States, to Germany, and to France, it is at least ten times as important to the parts of the earth that have less advanced economic development. It is in the countries of South and Central America, of Asia, and of Africa that air transportation really comes into its own, and as each such area in turn becomes its beneficiary, the neighbors fix envious eyes upon it and set about a restless search for airlines of their own. As aeronautical advance has created equipment that could span one natural obstacle after another, the people who live beyond the obstacles have displayed a steadily mounting eagerness for the coming of the airplane on a regular schedule.

WITH a hemispherically patriotic pride we can look upon the record and see that the eager reaching out after the benefits of a New Deal in transportation has been particularly characteristic of the peoples of the Americas. Although the air is physically free, and although surface obstructions have been yielding to the increased range and generally improved performance of airplanes and to the restless thrust of the pioneer, unhappily there is little political freedom to parallel the physical. The repeated interruptions of service on the airlines across Asia, and the repeated necessity of change of routes in order to avoid some particularly recalcitrant government, have become an old story to European airline operators and to students of the international politics of aviation. That practically nothing of the sort happens and that no such interruptions or changes become necessary on the western side of the Atlantic is a tribute to the diplomacy of the people who run the lines and to the confidence that they command, but a tribute too to the forward-looking and co-operative spirit that has generally prevailed among the governments along the way.

In dealing with governments it is desirable, and in fact almost necessary, to speak with a single voice.

A Personal Leave-Taking

HAVING been appointed by the President as a member of the newly created commission to recommend an air policy, necessarily at this point I withdraw for the time being from any connection with the editorial direction of AVIATION. As I go on my leave of absence I look forward to a return to the pages of the paper upon the completion of the commission's work, but in the meantime it remains in the very competent and highly qualified hands of those who have been most closely and actively associated with me in its direction over the past several years.

EDWARD P. WARNER

Domestic air transport in the United States has always been on a competitive basis as a matter of fixed principle. In the domestic field that works nicely. In foreign operation it has appeared to our government, as to every other in the world, that the results of competition among groups of our nationals would be deplorable. Hence, Pan American Airways, started six years ago with one finger tentatively reaching out across the Straits of Cuba, now girdling and cross-cutting the whole of South and Central America and Mexico and the West Indies, furnishing air service to the cities of Alaska, sending expeditions into Greenland and looking speculatively to three or four alternative routes across the Atlantic, and despatching planes with passengers and mail along the course marked out by the turbid Yangstze.

IN RUNNING an overseas air service, and especially one that has to contend with unusual natural difficulties, there are a few fundamental conditions that must be met. All successful operations along the great world air routes, under whatever flags, have shared a common attitude toward certain problems, and Pan American has been among the leaders in divining the essentials of successful operation and in clinging to them. Needless to say, the equipment must be the best that engineering knowledge can provide and it must be improved as rapidly as the state of the art permits. Needless to say, the personnel must be of the highest order of competence, with the widest possible experience in the sort of conditions they have to meet, and they must be knit together by an *esprit de corps* which is even more important in a world-covering organization than in a domestic one. Beyond that, there must be on the part of all concerned a constant consideration for the feelings and the traditions and the inclinations of the peoples among whom the organization does its work. There must be a relentless struggle against the red tape that often slows operations and increases their costliness, at the same time that it strews petty annoyances in the way of the individual patron of the line—a struggle which has recently had a happy outcome in one particular instance in the creation of an international air express service covering the whole Western hemisphere south of the Canadian boundary line and freed from those aggravations of multiple consular and customs documents with which the user of express either on the surface or in the air has in the past had to contend.

Finally, though there may be and is keen international competition in these foreign fields, if anyone is to have any chance of success there must be a reasonable measure of good sportsmanship and co-operation. Sometimes international agreements are made merely in the interests of economy, as when two nations pool their activities to provide a more frequent service than either one could provide alone. Sometimes they are made to ally two or more countries in combat against another, but it may reasonably be hoped that to an increasing degree they will represent a true international co-operation for the common good. In that, too, Pan American Airways has been among the leaders, and the harmonious agreement between Pan American and the major air transport interests of Europe for a common effort toward the development of carrying aviation across the North Atlantic and for a pooling of experience in that field is a brilliant example of the possibilities of working together even beyond national boundaries. While each nation continues active in the promotion of its own interests, the farther we go toward international understanding the more rapid will be our progress in the upbuilding of regularly served world air routes on a truly world-wide basis.

Partnership Agreement

THE REPORT of the Baker Board to the Secretary of War is now a matter of recorded history. It is a source of some satisfaction that many of the proposed reforms have been publicly urged in the editorial columns of AVIATION for many months past. Out of the lot, however, we are particularly hopeful over the prospects of a better understanding between the Air Corps and the aeronautical industry at large.

Back in November 1933 we pointed out that the attitude of the government toward manufacturers of aircraft and allied products should be that of one partner to another in an enterprise of national importance. By no stretch of the imagination could the relationships of the past decade be considered in that light. Manufacturers with hundreds of thousands of dollars tied up in inventory and plant equipment and with staffs of skilled engineers and craftsmen trained at great expense to work together efficiently have had to accept what was handed to them in the way of orders—and like it. When orders came in, all was well,—when they were withheld, factories stood idle, organizations disintegrated.

Now, we hope the days of feast or famine are over. We hope that those who direct the future purchasing policies of the Air Corps will recognize the essential soundness of the Board's conclusion, that unless manufacturers are encouraged by a continuous, controllable and predictable stream of government orders in times of peace, it is highly improbable (considering the present state of commercial and private markets) that even the nucleus of an efficient mass production scheme can be maintained for emergency expansion.

In these days of planned economy there are probably few governmental functions where long range planning is of more importance than in maintaining the integrity of our air defenses. Let us plan our spending, therefore, not only to satisfy immediate requirements, but also with an eye toward guaranteeing the continuous existence of an essential industry.

NEWS OF THE MONTH

★ SERVICES . . . Baker Board recommends increase in Air Corps strength. . . . Foulois submits program for purchase of 1,000 planes in 1936. . . . Army and Navy make mass flights to Alaska.

★ FEDERAL AVIATION COMMISSION . . . President appoints board of five to formulate an American air policy.

★ AIR MAIL AND TRANSPORT . . . I.C.C. establishes bureau to investigate air mail costs. . . . Transcontinental & Western Air begins overnight coast-to-coast passenger service. . . . Pan American and Railway Express expedite shipping procedure to Latin America. . . . S-42 breaks eight more world records. . . . Air-line representatives discuss maintenance problems in Chicago. . . . Code Authority for Air Transport Industry chosen.

★ MISCELLANEOUS. . . . Fifth annual meet of the Soaring Society of America closes at Elmira. . . . Second American stratosphere flight. . . . National Air Races.

Baker Board reports

DECLARING that the fighting strength of the Army Air Corps is below that of other world powers and should be substantially increased to insure adequate national defense, the Baker Board (see AVIATION, May, page 155) submitted its report to Secretary Dern on July 18. The immediate purchase of at least 820 planes to bring the Army's aircraft total up to 2,320, with a corresponding increase in fighting personnel was recommended.

It found that in spite of the Army's deficiencies as to actual numbers of fighting planes, the U.S. has developed and tested combat types of performance superior to that of any other power, judging by the characteristics of the military aircraft of foreign nations. Insofar as total numbers of Army and Navy planes are concerned, the latest statistics indicate that the U. S. stands second of the great powers with a combined strength of 2,800 planes. Russia and France are first with 3,000, Japan has 2,500, and Great Britain 1,400. Praising our civil and Naval aviation as the finest in the world, the committee said that, with more financial support, military aviation could also attain a superior position, since most of the matters demanding remedial action are directly traceable to lack of funds.

In discussing procurement methods, the committee declared itself to be strongly in favor of the policy of negotiated contracts. In its opinion, the Procurement Act of 1926, described as a far-sighted piece of legislation, permits three methods of purchasing equipment: purchase after design competition, purchase by negotiation, and purchase by open competition, all of which are necessary if the United States hopes to maintain its efficiency in the air. If, in the discretion of the Secretary of War, the existing law does not authorize negotiated contracts, immediate efforts should be made to secure amendments giving that authority. Proprietary design rights should be fully recognized.

The unification of all air services under one executive department was opposed. The soundness of our traditional policy of maintaining separate civil and war functions has been well demonstrated, the committee said, and a revision would jeopardize national defense and create unnecessary financial burdens.

Separation of the Air Corps from the supervision and control of the Chief of Staff, sought by Representative McSwain in the last session of Congress and supported by certain Air Corps officers (AVIATION, March, page 94), was likewise opposed. Major James H. Doolittle dissented from the general opinion of the committee on this point and filed a minority report stating his conviction that the air force can be "more rapidly organized, equipped and trained if it is completely separated from the Army and developed as an entirely separate arm."

The establishment of a General Headquarters Air Force under a commanding officer who would report directly to the Chief of Staff of the Army and who would have charge of the training, operation and direction of this special combat arm was recommended. This proposal was advanced last fall by a group of officers headed by Major General Hugh A. Drum, deputy chief of staff, and later presented to Congress with the new five-year plan to modernize the Air Corps (AVIATION, March, page 94). The GHQ Force would leave the Chief of the Air Corps free to devote himself to procurement and maintenance matters. In this connection it was urged that the engineering and procurement divisions of the office of the Chief of Air Corps be perfected in organization. Officers should be developed who are specially qualified in engineering and in dealing with industry.

The Army's experience in carrying the mail last winter taught invaluable lessons, the report said. Though Army fliers trained and equipped for military missions could not be expected to function as mail pilots with the efficiency of experienced civilians, nevertheless, after the initial period of bad weather, the mail went through promptly to the great credit of the Air Corps.

Shortly after the publication of the Baker Report, Chief of the Air Corps Foulois submitted to the General Staff a purchasing program for 1936, providing for 1,000 new planes to bring the

Calendar

Aug. 28-Sept. 15 — International Touring Competition, Aero Club of Poland.

Aug. 31-Sept. 3 — National Air Races, Cleveland.

Sept. 10-16—Sixth Indiana Air Tour.

Sept. 15-30 — Soaring Contest, Soaring Society of America, Big Meadows, Va.

Sept. 23 — Annual Gordon Bennett Balloon Race, Warsaw, Poland.

Sept. 27-29—Fourth annual Meeting, National Association of State Aviation Officials, Cheyenne, Wyo.

October — MacRobertson International Air Race, London to Australia.

Nov. 16-Dec. 2 — Exposition Internationale de L'Aeronautique, Grand Palais, Paris, France.

Dec. 15-16—Viceroy's Challenge Trophy 700-mile race, India.

Air Corps quota up to the recommended 2,320. Since the program is dependent on appropriations made by the next Congress, the outcome of this schedule is somewhat uncertain. Congressional appropriations for the current fiscal year (about $11,000,000) provide for the purchase of about 450 planes, and bid invitations have either been sent out or are already prepared. In addition to the 81 Martin bombers on order for the Air Corps, invitations have lately been sent out for 115 attack planes, all to be paid for with PWA's $7,500,000.

Army-Navy Alaskan flights

As the Baker Board was finishing its analysis of the Air Corps, ten Martin bombers took off from Bolling Field, Washington, on the Army's 7,335 mile flight through Western Canada to Fairbanks, Alaska, and return. Besides being a training and photographic mission for Army pilots, the flight will also determine if a heavy load of bombs can be successfully transported to a distant military objective. With a cruising range of 1,500 miles, cruising speed of 200 m.p.h., the Martin B-10's, Cyclone powered, are generally conceded to be the most efficient planes of that type yet developed. In direct command of the flight is Lt. Col. Henry H. Arnold, commanding officer of March Field, California.

Bound for Dutch Harbor in the Aleutian Islands, 350 miles due south of Fairbanks, twelve Martin PM-1 patrol boats left the Naval Aircraft base at San Diego two days before the Army's take-off. To be made in easy stages, the round-trip will cover approximately 7,700 miles. Its purpose is to familiarize Navy pilots with flying conditions along the coastal route.

Air policy board

The Federal Aviation Commission authorized by the Air Mail Act of 1934 was appointed by President Roosevelt on June 30. Instructed to study all phases of aviation and the government's relation to each and formulate a broad national policy covering transportation and defense, the commission must submit its recommendations to Congress before February, 1935. Its five members are: Clark Howell, chairman, editor and publisher of the *Atlanta Constitution*, member of the National Coal Commission in 1922, and in 1932 a member of the National Transportation Commission; Edward P. Warner, editor of AVIATION, non-resident professor of aeronautical engineering at the Massachusetts Institute of Technology, formerly Assistant Secretary of the Navy for aeronautics (1926-29); Dr. Jerome C. Hunsaker, long time aeronautical engineer, head of the department of mechanical engineering at M.I.T.; Albert J. Berres, former official of the American Federation of Labor and of the U.S. Shipping Board, now secretary of the Motion Pictures Producers of America; Franklin K. Lane, Jr., World War flier, and associated with the Bureau of Aircraft Production during the war, more recently an attorney in California.

At the commission's first meeting in Washington on July 10, Col. J. Carroll Cone, assistant director of the Bureau of Air Commerce, was chosen executive secretary. Edward P. Warner was elected vice-chairman. It was announced that public hearings will be started in Washington next September. Meanwhile the commission will make a thorough first-hand study of a variety of aeronautical activities, both in this country and abroad. Mr. Howell has gone abroad to study air administration in England, France, and Italy, with particular stress on co-ordination of military and civil services and government subsidy of commercial and private flying. The other members are now air touring the United States and the West Indies, Panama, Central America, and Mexico. Their itinerary will include Army and Navy bases, aircraft factories, and airports.

In a recent communication from the Federal Aviation Commission, AVIATION readers who have information which may be of value in the study of the desirable future course of American air policy are invited to lay such suggestions before its members, accompanied by documentary or statistical material if possible. The commission's headquarters are in Room 5044, Commerce Building, Washington, D. C.

Maintenance conference

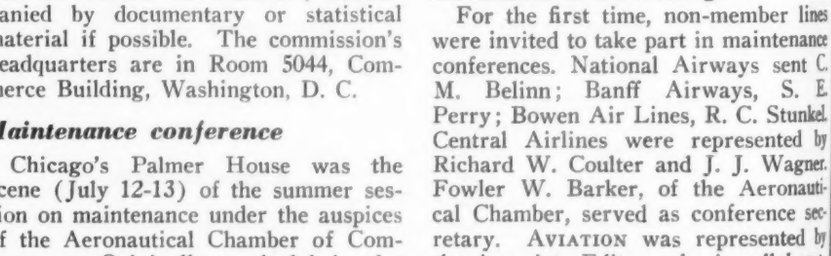
Chicago's Palmer House was the scene (July 12-13) of the summer session on maintenance under the auspices of the Aeronautical Chamber of Commerce. Originally scheduled for Brownsville (AVIATION, February, 1934) the locale was shifted (*a*) to avoid the heat of Texas summer, (*b*) to afford opportunity for inspection of American Airlines' new overhaul shops (*c*) to permit members to visit Chicago's Fair. Pan American will play host at Brownsville for the next mid-winter conference, January, 1935.

The agenda was made up of questions submitted in advance by member lines. Experience with various types of batteries, shock struts, tires, instruments, spark plugs, oils, fuels were exchanged in round-table talk. Engine overhaul methods, propeller servicing procedure, the protection of materials came in for full share of discussion. Future problems were anticipated in talk of larger airplanes, 110-volt electrical systems, quick detachable engine mounts, new de-icers.

Walter Hamilton (TWA), chairman of the committee, was prevented from attending by pressure of business on the West Coast. His functions as presiding officer were ably handled by C. N. James (General Air Lines), and Chairman Hamilton's assistant William Maxfield and R. E. Spengler presented TWA's problems. American Airlines were represented by H. D. Ingalls, John R. Ruden, Paul O'Neal, R. S. Atkinson, W. Littlewood (all of Chicago) and W. B. Click (Fort Worth). H. O. West and W. C. Mentzer spoke for United Air Lines. W. S. Rosenberger was on hand for Pennsylvania Air Lines & Transport. B. E. Fiertig (AA) kept the minutes of the meeting.

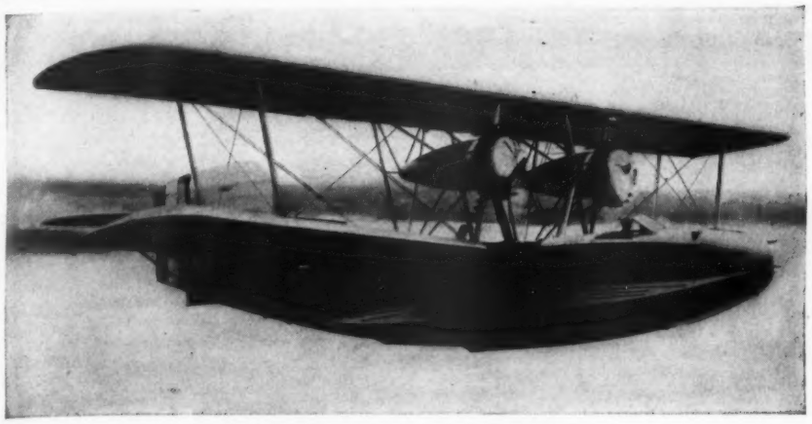
For the first time, non-member lines were invited to take part in maintenance conferences. National Airways sent C. M. Belinn; Banff Airways, S. E. Perry; Bowen Air Lines, R. C. Stunkel. Central Airlines were represented by Richard W. Coulter and J. J. Wagner. Fowler W. Barker, of the Aeronautical Chamber, served as conference secretary. AVIATION was represented by the Associate Editor, who is collaborating with the Committee and the Chamber on the maintenance notebook.

Although barred from the business



NEW LICENSEE

Department of Commerce has just issued approval on a new airplane designed and built by D. A. Luscombe at Kansas City. Full details on this interesting little ship will be available in an early issue.



NAVY FLIES NORTH

One of twelve Martin PM-1 flying boats which made the Alaskan flight. Of all metal construction except for the covering of the wings and tail surfaces, they are fitted with two 525 hp. Wright Cyclones. Their top speed is 120 m.p.h., cruising range, 1,200 miles.

session of the conference, a number of manufacturers of aeronautical equipment and accessories had men on hand to confer with maintenance men after the meeting. It is announced by the Aeronautical Chamber of Commerce that equipment and accessory manufacturers will meet in the future simultaneously with the maintenance men having separate meetings in the same cities.

New soaring records

After setting a new world record for distance soaring and beating the American altitude record, the Fifth Annual National Soaring Meet closed at Elmira, N. Y., July 8, with prospects for American soaring brighter than ever before.

Although in the course of the two weeks of the meet there were but few days of really good soaring weather, the 63 contestants made the most of them to establish a new high percentage of activity. In addition to the "D" rating won by Richard duPont, No. 32 in the world's roster, sixteen "C" certificates, sixteen "B's" and one "A" were issued. A total flying time of 117.31 hours were registered and 129 launchings were made. The M.I.T. meteorological field unit, under the direction of Dr. K. O. Lange, contributed substantially to the success of the meet. Dr. Lange was assisted by C. Harmantas, J. Namias and S. Lichtblau, meteorologists, and J. Barber, pilot.

Three days after the opening of the meet came the first good weather, promptly utilized by Richard C. du Point for his 155-mile record flight (AVIATION, July, page 24). Again on June 30 it was duPont who succeeded in breaking the American altitude record of 4,780 feet, held by J. K. O'Meara of New York City. Climbing from cloud to cloud in Albatross I it took him just one hour to reach a peak of 6,500 ft., 1,939 ft. less than the international record. On the same day, Lewin B. Barringer, Philadelphia pilot, flying the sailplane duPont used on his record distance flight, soared across a mountain, landed 77 miles away from Elmira at Ransom, Pa. Awards follow:

DISTANCE

Sailplanes

1. Richard C. du Pont ..... 155 miles
2. Lewin Barringer ..... 77.5 miles
3. J. K. O'Meara ..... 50.9 miles

Secondaries

1. Floyd Sweet .....24.25 miles
2. Stanley Smith .....11.87 miles
3. Joseph W. Conn.....10.5 miles

ALTITUDE

Sailplanes

1. Richard C. du Pont .....6,224 ft.
2. Lewin Barringer .....4,879 ft.
3. Martin Schempp .....4,519 ft.

Secondaries

1. Floyd Sweet .....3,517 ft.
2. Stanley Smith .....3,264 ft.
3. Dana L. Darling .....1,778 ft.

DURATION

Sailplanes

1. Martin Schempp ..... 6.08 hours
2. Richard C. du Pont ..... 5.53 hours
3. Emerson Mehlhose ..... 5.42 hours

Secondaries

1. Mrs. Dorothy Holderman ... 4.31 hours
2. Dana L. Darling ..... 4.26 hours
3. Mrs. Richard C. du Pont.... 4.21 hours

America was not to keep its world record long. At the soaring meet at Wasserkuppe, Wolf Hirth recaptured it with a flight of 225 miles on July 26. Two days later even this record fell when Heini Dittmar soared 235 miles from Wasserkuppe to Liban, Czeckoslovakia, in 6 hours, 25 minutes.

Intercontinental express

Faster and more direct express service to 150 Central and South American trade centers was inaugurated on Aug. 1 through the co-ordination of Pan American Airways' transport system with the Railway Express Agency. The improved service was made possible by a new and greatly simplified shipping document called the Pan American "airwaybill," effected after three years of negotiations with 30 Central and South American Governments. The airwaybill will largely replace the complex consular invoices, bills of lading, and other red-tape which formerly delayed express shipments at international borders. Hereafter, express will pass through the customs as fast as the luggage of the passengers.

According to the agreement which establishes a twenty-year partnership between the railroads and Pan American, each of the 23,000 offices of the Railway Express Agency will become receiving depots for international air express shipments. By means of this arrangement and the new airwaybill a business man in any part of the United States will be able to dispatch merchandise under a single carrying document and through a single service to any one of 30 foreign countries with practically the same ease and convenience as he can make domestic shipments. The express will be routed by air or rail to Pan American's terminals at Miami or Brownsville, Tex., and delivered to cities in the Caribbean area within 2½ days and to the most distant capital of South America within seven days.

Pan American Airways declared a dividend of 25 cents per share, payable Aug. 1 to stockholders of record July 20. This represents the first distribution to stockholders since the system was organized seven years ago, and amounts, approximately, to 1 per cent of the capital invested.

Marking the successful completion of nearly three months of severe engineering tests, Pan American's "Brazilian Clipper" was formally licensed by Director Vidal on July 3.

Service deluxe

Encouraged by the success of its sleeper plane service between Dallas and Los Angeles, American Airlines started it on the night run from New York to Chicago. Curtiss Condors with six lower, six upper berths are used. A week later a "club car" service was inaugurated over the route with the same Condors. By day their berths are convertible into commodious chairs.

The New York-Chicago service flown by TWA with new Douglas transports was extended to Kansas City. Flying time is 6 hours, 37 minutes. Coast-to-coast schedules were reduced from 24 hours to 16 hours. Planes leaving either coast in the late afternoon arrive at destinations early the following morning. One daily round trip on these schedules is flown with the Douglas planes to supplement slower services with older equipment.

The first all-air connections to Western Canada from Chicago and eastern

cities are provided by the extension of United Air Line's San Diego-Seattle route to Vancouver, British Columbia. From Seattle the hop of 131 miles is negotiated in 55 minutes with Boeing 247's. One round trip is made daily.

New Sikorsky records

In flight tests on Aug. 1, the Sikorsky S-42 (see page 246), averaging 157.7 m.p.h. over a 1,242 mile course, with a 4,409 lb. payload, broke eight FAI seaplane records, all previously held abroad, as follows:

1,000 kilometers (621.369 miles) with no payload restriction — Record, 138.116 m.p.h., (Germany).
2,000 kilometers (1,242.739 miles) with no payload restrictions — Record, 117.396 m.p.h., (France).
1,000 kilometers (621.369 miles) with 500 kilos (1,102.311 lbs.) payload—Record, 138.116 m.p.h., (Germany).
2,000 kilometers (1,242.739 miles) with 500 kilos (1,102.311 lbs.) payload—Record, 117.396 m.p.h., (France).
1,000 kilometers (621.369 miles) with 1,000 kilos (2,204.622 lbs.) payload—Record, 118.085 m.p.h., (France).
2,000 kilometers (1,242.739 miles) with 1,000 kilos (2,204.622 lbs.) payload—Record, 117.396 m.p.h., (France).
1,000 kilometers (621.369 miles) with 2,000 kilos (4,409.244 lbs.) payload—Record, 110.155 m.p.h., (Germany).
2,000 kilometers (1,242.739 miles) with 2,000 kilos (4,409.244 lbs.) payload—Record, 101.674 m.p.h., (France).

D. of C. agency for private flying

Another step toward the development of a low-priced easily handled airplane for novice pilots was taken by the Bureau of Air Commerce (on July 1 the Aeronautics Branch, Department of Commerce, was re-named) with the creation of a special Development Section. The new department will be financed by an allocation of $100,000, the Commerce Department's share of the $1,000,000 appropriation for aviation expenditures which the last Congress made to the President (AVIATION, April, page 119). It is the intention of the bureau to assist manufacturers in their endeavor to produce a plane with such a high safety factor and ease of control that amateur pilots who have logged a limited number of flying hours will be able to fly without hazard. Chief of the new unit is John H. Geisse, who has been in charge of the manufacturing inspection service of the bureau since June, 1933. Among his first duties will be the supervision of the purchase of the 25 small inexpensive planes for which bids will be opened on Aug. 27.

Bureau of Air Commerce officials and representatives of the scheduled air transport companies will sit down together on Aug. 15-16 to discuss the revision of Department of Commerce airline regulations. Rapid technical advances in airline operation since the rules were adopted several years ago have made them obsolete. Broader authority to provide standards of safety on the air lines was granted the Commerce Department in the recent amendments to the Air Commerce Act of 1926.

FOR PROPAGANDA IN THE USSR

The world's largest landplane "Maxim Gorky" stands ready for work in Moscow, complete with printing press and sound film recording apparatus. A feature of its construction is the subdivision of its power. Eight engines are installed. The two center engines are in tandem.

Hawaiian mail service

Bid invitations for air mail service in the Hawaiian Islands were sent out by Postmaster General Farley on July 6. The proposed service will link the four large islands of the group, Hawai, Oahu, Kauai, and Maui, and will embrace the principal cities of each, thereby serving 325,000 people. A total route mileage of approximately 333 miles will be covered, the longest over-water stretch being 93 miles. Multi-motored amphibions with passenger facilities and a minimum cruising speed of 100 m.p.h. are required. The Hawaiian service is the first to be advertised under the terms of the new Air Mail Law. At present the only inter-island mail service is a once-a-week ship mail service between some of the islands and a twice-a-week ship mail service between others. Establishment of the new service depends on whether the Post Office Department receives reasonable bids. Proposals will be received by the Department until noon on Aug. 27.

A mail contract at 16.7 cents per airplane-mile for the route between New Orleans and Houston, Tex., via Baton Rouge and Lake Charles, La., and Beaumont, Tex., was awarded to the Robertson Airplane Service Company of Robertson, Mo. The company was low bidder on the route.

Hanford Tri-State Airlines was successful bidder on the route from Bismarck, N. D., to St. Paul. The company will receive 18.9 cents per airplane-mile.

The contract for the route between Daytona and St. Petersburg, Fla., was awarded to the National Airline Taxi System (Franklin and Baker), low bidder at 17 cents.

An investigation of foreign air mail and ocean mail contracts was ordered by President Roosevelt on July 17. Postmaster General Farley was directed to hold public hearings upon any contracts entered into prior to June, 1933, and to formulate conclusions as to possible modification or cancellation. These recommendations are to include a specification of the amount of savings to the government if changes were made.

A Bureau of Air Mail, responsible for designating air mail routes, was established on July 5 by the Interstate Commerce Commission, acting under the authority of the new Air Mail Law. The bureau will also be obliged to ascertain if air transport lines are making unreasonable profits in handling mail.

Stratosphere again

After many months of thorough preparation and weeks of waiting for favorable weather, the balloon flight into the stratosphere sponsored by the Army Air Corps and the National Geographic Association got under way on July 28. From the take-off site in a valley near Rapid City, S. D., the balloon had risen, in the course of ten hours, to about 60,000 ft. when wide rents appeared in the fabric of the gas bag. The crew of three, Maj. W. E. Kepner, pilot, Capt. A. W. Stephens, scientific observer, and Capt. O. A. Anderson, alternate pilot, stayed with the ship until it fell to 5,000 ft., then jumped to safety in parachutes. One spectroscope tied to the outside of the gondola was cut loose and floated to the ground on its own parachute. Most of the other instruments used to record temperature and barometric readings, cosmic ray activity, and solar radiation

were demolished when the gondola crashed. The barographs, enclosed in a balsa wood box and insulated with sponge rubber, escaped serious injury, however, and established the official ceiling of the flight as 60,613 ft. [The world record is 61,236 ft., made by Lt. Comdr. T. G. W. Settle, and Maj. Charles Fordney last November (AVIATION, December, page 383).] No conclusion as to the reason for the tear in the balloon's fabric has yet been reached.

Stag party

The schedule of events for the forthcoming National Air Races at Cleveland discloses that women flyers are barred from every competition except the parachute jumps. The Ninety-Nine Club, an organization comprising most of America's women pilots, has asked the National Aeronautic Association to explain why the hard-won right of women pilots to compete on an equal basis with men has been suddenly revoked. This year's program, under the direction of Cliff and Phil Henderson, has been concentrated into four days (Aug. 31-Sept. 3) and is restricted to high speed free-for-all competition, eliminating complicated handicapping and trick races. Cash prizes totalling $35,000 will be awarded. As usual, the starting gun of the races will be the Bendix Trophy Race, transcontinental speed classic, and the Thompson Trophy Race, international free-for-all, is scheduled to be flown on Labor Day.

Code group named

The members of the Code Authority for the Air Transport Industry were recently approved by National Recovery Administrator Johnson. The five chosen by the Aeronautical Chamber of Commerce are: E. R. Breech, president, North American Aviation, Inc.; H. S. Martin, president, Pennsylvania Air Lines & Transport Company, Pittsburgh; W. A. Patterson, president, United Air Lines, Inc., Chicago; L. D. Seymour, president, American Air Lines, Inc., Chicago; J. T. Trippe, president and general manager, Pan-American Airways, New York.

Those selected by members outside the Chamber are: Temple Bowen, president Bowen Air Lines, Fort Worth, Tex.; T. E. Braniff, president Braniff Airways, Inc., Oklahoma City, Okla. O. Max Gardner, of Washington, D. C., former Governor of North Carolina, was appointed general counsel.

The Code Authority plans to abolish the issuance of passes for free transportation on air lines. The amendment to the fair practice clause of the code prohibiting passes will be thoroughly discussed at the next meeting in August.

The Aeronautical Chamber of Commerce of America will move its executive offices from New York to Washington, D. C., on Aug. 10. Since regulation and supervision of aviation are largely Federal, the Chamber believes that its members can be more quickly and adequately served by having the office located at the national capital. The aeronautical library and general information service of the Chamber will remain in New York.

PWA aids research

For the construction of a new high-speed wind tunnel at Langley Field, Va., the National Advisory Committee for Aeronautics received an allotment of $478,300 from PWA. The tunnel, to be completed within a year, will have an airspeed of 500 m.p.h. through a test chamber 8 ft. in diameter. It will replace the present high-speed tunnel and will make it possible to test airfoils of considerably larger size than those used with present equipment.

Martin bombers for Air Corps

A $3,195,450 contract was awarded by the War Department to the Glenn L. Martin Company for 81 bombers and spare parts. The company was the only bidder on the planes, purchased with PWA funds. A contract of $1,705,733 for 280 engines was awarded to the Wright Aeronautical Corporation.

The Navy Department awarded a contract for construction of seven landplane hangars at the San Diego base on a bid of $338,550.

The Stinson Aircraft Corporation reports sales amounting to $500,000 for the first six months of the present fiscal year, an increase of nearly 300 per cent over the corresponding period in 1933.

The exclusive distributorship for Lockheed airplanes in all of China, including Manchukuo, was granted to the Hoskon Trading Company, Inc., of New York and Shanghai. The franchise includes an option to secure exclusive license to manufacture the Electra, Orion, Altair, and Vega in China.

All British contest

The King's Cup Race, British handicap classic, was held at Hatfield near London on July 13-14. Flight Lt. H. M. Scholfield, flying a four-place Monospar with two Pobjoy engines, was the winner. His time was 133.515 m.p.h. Of the 41 starters only ten pilots got into the final stages of the race. The others were eliminated by the special rules of the contest.

Aviation People

Theodore P. Wright

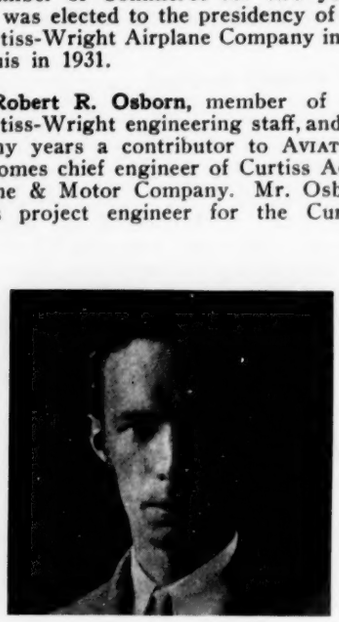
• A realignment of Curtiss-Wright's executive staff makes **Theodore P. Wright,** director of engineering for the corporation. Before the change Mr. Wright was vice-president and general manager of Curtiss Aero & Motor Company, and was recently elected chairman of the Curtiss-Wright Engineering Policy and Planning Committee. His affiliation with Curtiss interests dates from 1920 when, as a lieutenant in the Naval Reserve Flying Corps, he served as inspector of naval aircraft in the Buffalo and Garden City plants. Since 1921 he has been an engineering executive of the Curtiss Aeroplane & Motor Company, and since 1931, when the experimental laboratory of the Garden City plant was moved to Buffalo, the combined experimental research and production activities of the company have been carried on under his direction. Mr. Wright received the Wright Brothers medal in 1931 for his paper on "The Development of a Safe Airplane—'The Tanager.'" He is a member of the Society of Automotive Engineers, the American Society of Mechanical Engineers, Associate Fellow of the Royal Aeronautical Society, and a member of the first council of the American Institute of Aeronautical Sciences.

• Replacing Mr. Wright as vice-president and general manager of Curtiss Aeroplane and Motor Company is **Ralph S. Damon,** who will retain his position as president of Curtiss-Wright

Ralph S. Damon

Airplane Company of St. Louis. After his graduation from Harvard University in February, 1918, Mr. Damon taught at the Massachusetts Institute of Technology until June of that year when he enlisted in the Army Air Corps. In 1922 he joined the Curtiss Aeroplane & Motor Company at Garden City, Long Island, and later became project engineer, then chief inspector, and finally factory superintendent of the company. Under his supervision many famous Curtiss racers were produced, including two Schneider Cup winners. Employed as factory manager of the Curtiss-Robertson Airplane Manufacturing Company at St. Louis in 1928, he was elected vice-president the following year. Mr. Damon was chairman of the Manufacturers' Division of the Aeronautical Chamber of Commerce for two years. He was elected to the presidency of the Curtiss-Wright Airplane Company in St. Louis in 1931.

• **Robert R. Osborn,** member of the Curtiss-Wright engineering staff, and for many years a contributor to AVIATION, becomes chief engineer of Curtiss Aeroplane & Motor Company. Mr. Osborn was project engineer for the Curtiss



Robert R. Osborn

Tanager, winner of the Guggenheim safety contest, and more recently has been special assistant to Mr. Wright.

• At Detroit the new city traffic manager of American Airlines is **Frederick S. Cowen.** Formerly assistant city traffic manager, Mr. Cowen graduated from the school of aeronautical engineering, University of Michigan in 1930. After two years of active duty with the U. S. Naval Reserve, he became traffic representative for Transamerican Airlines Corporation, now a division of American Airlines. Mr. Cowen succeeds **Charles R. Speers** who becomes district traffic manager for the Chicago district.

• Assistant to the Chief of the Air Corps with the rank of brigadier general for a four year term is **Lt. Col. James E. Chaney.** Colonel Chaney is now on duty in the office of the Chief of Air Corps, but is expected to assume command of some one of the Army fields, as soon as he is relieved.

• **W. J. Crosswell,** sales pilot for the Curtiss Aeroplane & Motor Company, has returned to Buffalo from South America. He spent three months in Columbia demonstrating Curtiss Hawks and Falcons recently purchased by the government of that country.

• In charge of legislative affairs for United Air Lines for the past several years, **Cyril C. Thompson** was recently elected to the secretaryship of the company.

• New publicity representative for United's Eastern area is **Frank L. Curtis,** formerly aviation editor for the N. Y. **Sun.** Mr. Curtiss has also been in charge of publicity for American Airlines, the Sikorsky Corporation, and the Seversky Corporation.

• Appointment of **Charles F. McReynolds,** well-known aviation writer, to take charge of advertising and public relations for the Menasco Manufacturing Company has been announced. Mr. McReynolds has been active in aeronautical enterprises on the Pacific Coast over a number of years, and was formerly western editor for **Aviation.**

• As aviation chemist in charge of development, testing, and research on aircraft finishes, **Harold Acker** comes to Berry Brothers. For the past five years Mr. Acker has been employed at the Naval Aircraft Factory at Philadelphia, where he was engaged in the development of organic protective coatings.

• Traffic representative of United Airlines in their new Vancouver office is **W. J. Dalby,** who will be in charge of bookings between Seattle, California and the East.

• Manager of the Milwaukee office of Pennsylvania Airlines & Transport Company is **Harold Callahan.** He was formerly with Kohler Aviation Corporation, recently merged with Pennsylvania Airlines.

• An international authority on aeronautical law joins Pan American's executive staff with the election of **John C. Cooper, Jr.,** as vice-president. Chairman of the United States delegation to the International Conference of Air Law held in Rome in May, 1933, Mr. Cooper was one of four Americans appointed by the State Department last winter to serve on an international committee engaged in developing a world code for private flying (AVIATION, February, page 55). A graduate of Princeton, Mr. Cooper has been for many years a member of the law firm of Knight, Adair, Cooper and Osborn in Jacksonville, Florida. He is a past president of the Jacksonville Bar Association and the Florida State Bar Association.

Under new policies recently announced by President Trippe the Foreign Department in New York will be merged with the executive Department. **George L. Riehl,** vice president and formerly division manager, Brazilian division will have permanent headquarters in N. Y.

At the same time several field promotions were affected in the organization. **W. O. Snyder,** formerly division engineer has been appointed to the position of acting division manager of the Caribean division. His place is filled by **H. W. Toomey,** formerly division traffic manager in Brazil. **M. J. Rice** has been appointed to the position of Acting Division Manager. **F. M. Blotner** was promoted to the office of Acting Operations Manager, Brazilian division.

• The command of the Anacostia Naval Air Station was assumed by **Comdr. Alfred E. Montgomery** early in July. Acting commandant of the station, **Lt. Comdr. William K. Harrill,** will remain in his former post as executive officer. Commander Montgomery qualified as a naval aviator in 1922 and has served with the aircraft squadrons of both the scouting and battle fleets. He commanded the naval air station at Seattle from 1930 to 1932 and then was appointed aviation officer on the staff of the commander of the cruiser division of the scouting force. He has served in the office of naval operations since 1933.

• Several promotions were recently announced by Eastern Air Lines. **Capt. Charles W. France** was appointed vice-president in charge of operations, succeeding **Harold A. Elliott.** Captain France had been serving as operations manager for the company and before that was division superintendent for Western Air Express. His first connection with aviation was during the war when he joined the aviation division of the U. S. Army, Signal Corps in 1917.

Charles W. France

• General superintendent of E.A.L. is **George R. Cushing,** who was vice-president before his new appointment. He has been identified with Eastern air and its predecessor companies since their founding, starting as night dispatcher. He holds the rank of lieutenant-colonel on the staff of the Governor of Georgia and is the Governor's advisor on aviation matters.

• **John K. Ottley, Jr.,** formerly southern division traffic manager, has been named assistant general traffic manager. He will serve under L. Edwin Gill, vice-president in charge of traffic. Mr. Ottley has also been connected with Eastern Air since its inception.

• In charge of air mail development for the company is **C. W. H. Smith,** who was appointed mail traffic manager. Mr. Smith has been employed in air transportation since 1926 and is considered an expert in air mail traffic. He has been connected in the past with Western Air Express and also TWA.

Flying Services and Flying Schools

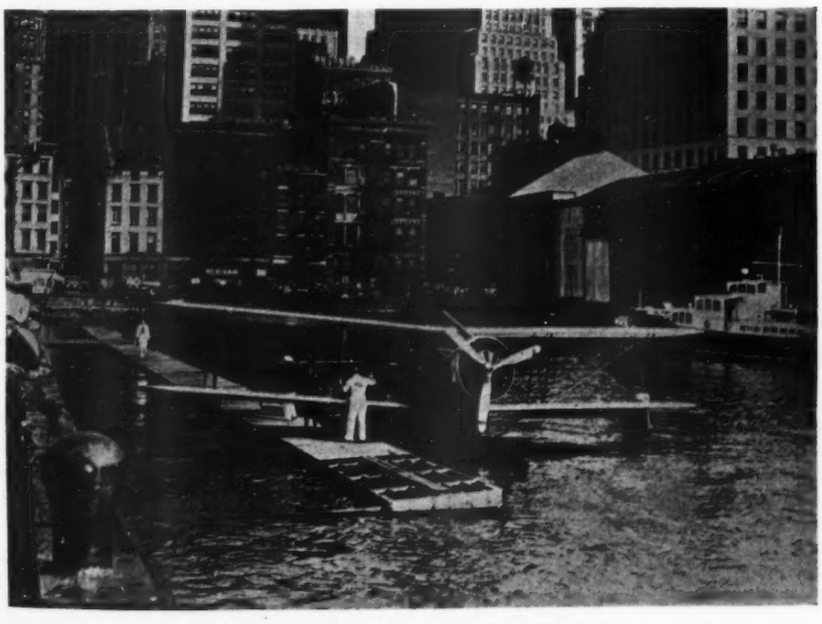
• A proposed code of fair competition for the Commercial Aviation Industry was submitted to the National Recovery Administration on July 10, by the Independent Aviation Operators, sponsors of the code. It covers all miscellaneous activities not already covered by the Air Transport and the Aircraft Manufacturing Codes and includes taxi and charter services, the operation of airports and schools, servicing and repairs, and selling and distributing. In presenting the code, Louis R. Inwood, secretary of the Independent Aviation Operators Association, emphasized the fact that it would have to be administered on a regional basis. With the complexity of the industry and the large number of small operators within its folds, it would be impossible to make national regulations binding upon every individual region, he said. The code provides for this regional government by dividing the country into eleven districts, each consisting of a group of adjacent states. A Regional Code Authority of five voting members is provided for each district. The members of the Authority will be selected by members of the industry in the various regions.

The National Code Authority consists of thirteen voting members, eleven of whom are to be elected by the Regional Code Authorities. The twelfth will be the President of the Independent Aviation Operators Association, and the thirteenth, representing non-members of the Association, will be appointed by National Recovery Administrator Johnson. In addition, one or more non-voting members may be appointed by the Administrator, one of whom must be a representative of the Department of Commerce.

The Regional Code Authorities are empowered to prescribe a standard procedure and principles for determining the cost of products and services for their respective districts. No member of the industry is allowed to sell services or products below this established cost.

Throughout the entire industry irrespective of region a maximum work week of 40 hours is specified. Pilots are limited to 100 flying hours per month. Minimum wages range from $15 to $13 per week according to regional population. Mechanics with Department of Commerce licenses shall, however, receive at least $16 weekly, licensed transport pilots $20.

• A seaplane commuting service from Oyster Bay directly to the foot of Wall Street on the East River affords New York business men, living on Long Island, easy access to their offices. The New York and Suburban Airlines, Inc., has started the service with a Bellanca Airbus on floats powered with a 575-hp. geared Wright Cyclone. A Keystone Commuter is used as a reserve plane. The present schedule leaves Oyster Bay at 9 every morning from Monday through Friday, stops at Port Washington ten minutes later and arrives at Wall Street at 9:25. In the evening the seaplane makes two trips, one at 4:15, the other an hour later. On Fridays a run to Martha's Vineyard, Nantucket, is scheduled, with a return trip to Manhattan on Sunday evening. E. O. McDonnell, president of National Aviation Corporation, an air investment company, is president of the new airline. Frank F. Russell, vice-president and secretary of National Aviation, is vice-president. Chief pilot and general manager is Stanley J. Jacques, who has flown in and out of the East River almost daily during the past two years, as pilot for Richard F. Hoyt, chairman of the board of the Curtiss-Wright Corporation and well-known private flier.



MANHATTAN TRANSFER

Commuting service from Long Island to the foot of Wall Street is operated daily by the New York and Suburban Airlines. The initial trip on July 16 was made by the Keystone Commuter tied up at the dock. Regular service is now being maintained with a Bellanca Air Bus on Edo floats. This temporary landing stage will soon be replaced by one of the large ramps, now being built for the city.

• To foster the development of air-commuting the Dock Department of New York City is building two large seaplane ramps to serve as public aircraft terminals. They are at present still in the process of construction at the Brooklyn Navy Yard, and are being built with funds allotted under the Temporary Emergency Relief Administration. Each of the two ramps will weigh 165 tons and cover an area of 85 by 45 feet. Each will be equipped with an electrically operated turn-table, fueling station, and a passenger waiting room. One of them will replace the temporary landing float at the foot of Wall Street and will provide parking facilities for 30 seaplanes. The other ramp will be located at the foot of East 31st Street with parking facilities for twenty seaplanes.

New York and Suburban Airlines has contracted with the city to operate both of these ramps when they are placed in service.

• Fourteen seaplanes took off from the beach of the Sands Point Bath Club on Friday, June 13, on the fourth annual invitation cruise of the Long Island Aviation Country Club. Despite the psychological handicap of the starting date and the dubious weather, all but two of the planes arrived safely and speedily at their destination—Wellesley Island in Alexandria Bay on the St. Lawrence. Of the others, one dropped by the wayside at Schenectady and its occupants were forced to continue by train; the second turned back for additional weather reports, ran into thunder storms and was delayed in arriving. Chief sensation of the cruise was the performance of the new Courtney amphibion, piloted by Richard F. Hoyt (see *Flying Equipment*, page 269, for technical description). The cruise committee consisted of Mr. Hoyt, Commodore; George B. Post, Fleet Captain; and Rudolph R. Loening, Chairman of the Cruise Committee.

• With 180 students enrolled, the Casey Jones School of Aeronautics in Newark, N. J., recently moved into larger quarters. This is the third expansion the school has made within the last eighteen months as the result of a steadily increasing enrollment, and places it as one of the largest non-military schools in the world for aviation mechanics and engineers.

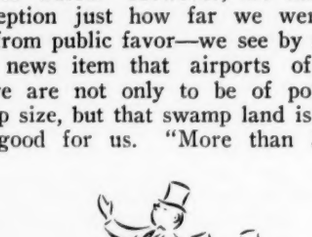
• A report from Parks Air College shows, with but one exception, a marked increase in monthly receipts over the first seven months of 1933. This year's total to date is nearly three times as great as that of

the corresponding period last year. The recent three-weeks' vacation period for the student body was utilized as a research period by the instructors. Parks' three pilots, George Gruen, Harvey Parks, and Harvey Glass, made a tour of the TWA system. William M. Thompson, chief of the mechanics school, visited Langley Field and Wright Field. Others of the faculty inspected various airline bases and manufacturing plants in the mid-western area and on the west coast.

SIDE SLIPS

By Robert R. Osborn

REMEMBER the golden days of 1928 and 1929 when aviation was riding the crest of the wave of public popularity, and nothing was too good for us? Then every town and city was offering to the local airport its choice of locations in the neighborhood, even if it was necessary to move the town hall and the public library to make enough space for the flying operations. Then followed a period when we saw many notices in the papers that this or that city had set aside a section of swamp land, ten or twenty miles out of town, to be drained by a couple of ditches and made into the municipal airport, and many farming gentry were making inquiries as to what type of plow would be best for turning over concrete runways. We were then beginning to suspect that possibly we weren't quite as popular as we had been—that matters might even go from bad to worse. However, we had no conception just how far we were to fall from public favor—we see by a recent news item that airports of the future are not only to be of postage stamp size, but that swamp land is now too good for us. "More than 3,100



sq.ft. of land, now under water at Manila, P. I., have been acquired, through proclamation, by the governor general of the islands, for development as a city airport." (Thanks to M.L.T. of Elizabeth, N. J., for the clipping.)

Ever since last April we have been waiting anxiously for the official confirmation of the altitude flight made by Renato Donati near Rome, Italy. We happened to be in Norfolk, Va., at the time and the *Virginian Pilot* carried the news item, "The civilian pilot required but 75 minutes for his flight, which his instruments revealed had taken him to 14,500 meters or 47,572.0785 ft. into the heavens. The existing recognized record is held by G. Lemoine, of France, who soared 44,819.418 ft. in 1933. Official figures on Donati's flight will be known tomorrow, when the barograph is to be opened." Why is it we haven't heard more about the official figures on this flight? Can it be that someone forgot to adjust the decimal point on the barograph before the flight was started?"

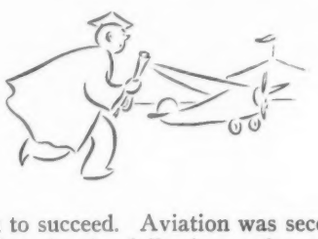
Our great campaign for honesty in airplane performance advertising has at last begun to show signs of success—although we'll have to admit that the improvement is really not much to talk about. Mr. G.S.L. calls our attention to a recent description, in the New York *American*, of one of the planes to be entered in the London-Australia race—"Powered by a Wright Cyclone of 715 hp. the plane will have a top speed of 225 m.p.h., a cruising speed of 235 m.p.h., and a service ceiling of 28,000 ft."

We have often suspected that the advertised cruising speeds of most airplanes were not far from the top speed, but we are surprised to find a manufacturer who'll admit his claimed cruising speed is higher than the top.

"'The Chinese Government now has a fleet of 00 planes and pilots who are highly trained and efficient,' Hawks said. 'The flying corps is under command of Col. Jack Jouett, former United States Army flyer, who has accomplished wonders.'" News item found in the New York *Herald Tribune* by L.W. who writes in to inquire if Postmaster General Farley's viewpoint on aviation has been adopted by newspaper writers.

Any designer who might be at all "touchy" about the pet names given to his airplane models had better stay away from the Navy Flight Test Section at Anacostia, as the pilots in that group have a habit of renaming most of the airplanes sent to them for test. One airplane which was found to have a serious wing vibration was nicknamed "The Humming Bird," and an amphibion which proved to be difficult, for a time, to get off the water was called "The Penguin." Two airplanes which had fat tummies on their fuselages were given the names "Capon" and "Flying Bologna." Another design which had a high glass cabin for the rear gunner was called "The Tower of Jewels" and another amphibion, because of the advance promises of its designer was named "X——'s Pleasant Surprise."

In the past, whenever some pilot has made some outstanding flight, or has set a record of some sort, he is always quoted in the papers as saying, "Aw shucks, I really didn't accomplish hardly nothing. It was easy. I just got in my airplane and did it." We always knew that no good would come of such unbecoming modesty on the part of our aviators, and now you see what has happened—The New York *Times* reports that students from 103 Eastern Colleges attending a Choosing-a-Career Conference in New York, "voted selling to be the easiest job in



which to succeed. Aviation was second, and then in the following order came entertainment, advertising, insurance, politics, government work, accounting and banking."

Before any of you young folks start rushing into this business, however, let me call your attention to the fact that this conference decided that the brokerage business offered "the least work with the biggest financial return."

Our Hangar Flying Department

THIS story about Lt. Rhea Taylor, of the Navy, has been passed around in the services quite a bit, but we think it is worth repeating for the benefit of AVIATION readers who might not have heard it. Rhea was the leader of a formation of two-seaters flying off of the deck of the Saratoga during the recent maneuvers. One day, on the west coast part of the cruise, some water got into the gasoline supply and four airplanes had to make landings in the sea after their engines had passed out—all of them getting away with their landings nicely, incidentally. As formation leader Rhea was in touch with the aircraft carrier by voice radio, and his call back to the ship is reported to have been as follows: "Saratoga, Emergency! Saratoga, Emergency! Airplane number four just dropped into the water off the starboard bow! Saratoga, Emergency! Saratoga, Emergency! Airplane number two just landed into the water two miles ahead of the ship! Son of a gun—here I go in too!"

FLYING EQUIPMENT

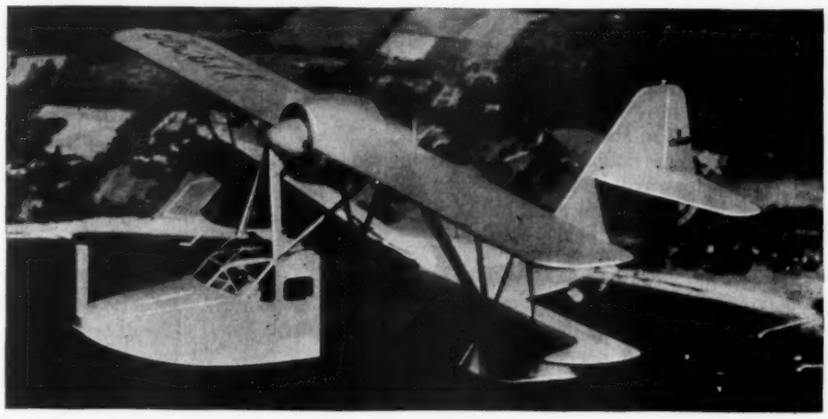
Novel Amphibion

FEW PERSONS have had as extensive a background in practical aerodynamics as has Capt. Frank Courtney, longtime test pilot, engineer and designer. Readers will recall him as a frequent contributor to AVIATION. After almost two years of design, experiment and construction he has recently test flown a new amphibion embodying a number of novel features which he designed and supervised the building for the Curtiss-Wright Corporation.

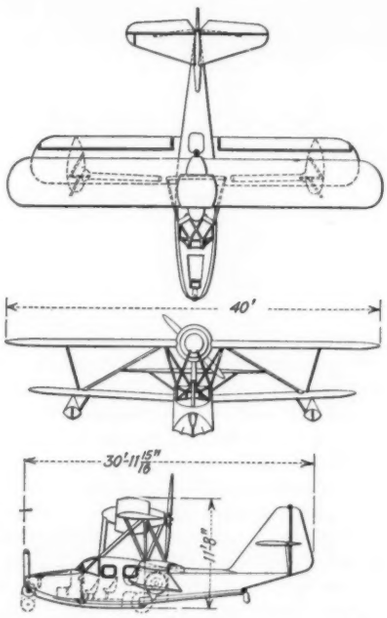
Principal departures from the conventional lie in the landing gear and in the power plant arrangement. Aiming to avoid the frequently unpleasant ground-looping tendencies of many amphibions caused by high C. G. position and wheels well forward, the two main wheels have been placed well aft of the C. G., with a retracting nose wheel set into the hull at the bow. With this arrangement, the ship may be landed in about the same position on water or on the ground. Brakes may be applied instantly and fully without ill effects. Another advantage—secondary, but nevertheless important—is structural. The wheels and the retracting gear may be housed without trouble in the section of the hull behind the passenger compartment. When in the "up" position the wheels lie in recesses in the hull side plating—practically flush, and adding very little drag. The wheel at the bow, when retracted acts as a pneumatic nose bumper. to prevent damage when moving.

As for power plant, Captain Courtney has endeavored to combine the advantages of a pusher installation for flying boats with high propulsive efficiency by avoiding the usual direct propeller mounting on the engine shaft. His nacelle-wing combination differs from anything that has yet appeared. The 365-hp. Wright Whirlwind engine is mounted in the center section of the upper wing between the spars and the propeller is located behind the trailing edge of the wing—driven through a 30-in. extension shaft carried on an independent outboard bearing. The housing around the engine has been the subject of much research so that the combined effect of the flow around both wing and nacelle will give minimum disturbance to the air entering the propeller. The nose of the nacelle (which, incidentally serves as a cooling surface for oil) lies well ahead of the leading edge, and the body tapers down smoothly to the propeller hub at the trailing edge.

The overhead engine with pusher propeller, together with the extreme degree of stagger of the biplane cellule makes possible an exceptionally good field of view for the five occupants of the cabin. The latter lends itself well to a variety of arrangements. Access is through a large hinged hatch forward. Large baggage spaces are available under the forward deck, and aft of the cabin. The after compartment may be reached either from outside or from within.



The Courtney-Curtiss-Wright amphibion during flight tests. The short mast at the bow houses the nose wheel retracting gear.



The hull is constructed entirely of Alclad and dural, anodized and painted. The fin is built into the stern of the hull. All tail surfaces are of dural, fabric covered. Wing framing is all wood—spruce beams and spruce ribs. The main center section members around the engine and outboard heaving are of welded steel tube. Ailerons are all duralumin. Main wing surfaces are fabric covered. There are no external wires, all bracing used being by rigid streamline struts.

The machine will carry pilot and four passengers (850 lb.); baggage (120 lb.); gasoline (80 gal., 480 lb.) and oil (6¾ gal., 50 lb.); and miscellaneous marine gear up to 50 lb. The empty weight is 2,980 lb., giving an all-up figure of 4,530 lb. The design gross is 4,650 lb. leaving an allowance of 120 lb. for radio, special instruments, special furnishings, etc. If the amphibion gear is removed, an extra 400 lb. load may be easily accommodated. Top speed (at 2,150 r.p.m.) is reported at 151 m.p.h.; cruising speed (at 1,800 r.p.m.) is 125 m.p.h. Sea level climb is 835 ft.p.m., absolute ceiling 16,200 ft. General specifications include: span, 40 ft.; length overall 31 ft.; height (from hull bottom) 11 ft. 8 in., (on wheels) 12 ft. 2 in.

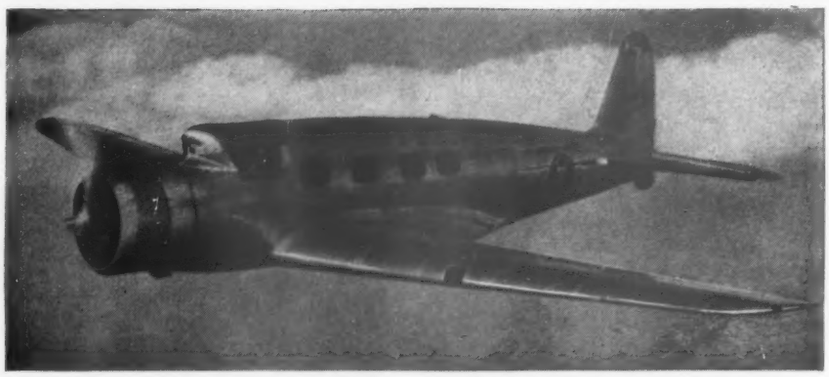
Vultee Transport

WELL over a year ago Gerard Vultee, former chief engineer for Lockheed Aircraft, completed and flight tested the first of his single engine, low wing, all metal transports. The machine at that time showed considerable promise for high-speed passenger work where single engines could be used, and within a few months the Airplane Development Company, one of Mr. Cord's many interests, placed production orders for twenty units to be used on certain routes of American airlines. The first of the twenty is now in service and although it retains the basic elements of the V-1 (covered in some detail in AVIATION, April, 1933) the V-1A shows a number of features that have been added during the experimental work of the past year.

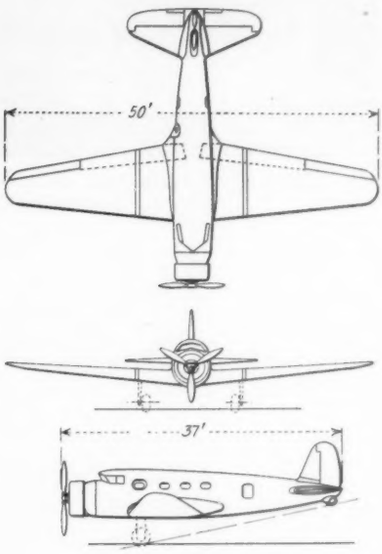
The overall dimensions of the machine have been increased slightly. Whereas the span of the first model was 48 ft., the V-1A is 50 ft. Overall length has been increased from 35 ft. 6 in. to 37 ft., and the wheel tread extended from 10 ft. 2 in. to slightly over 12 ft. The cross-sectional dimensions have also been increased. The fuselage width and height were formerly 56 in. and 62 in., respectively, the corresponding figures are now 58 in., and 68 in. Certain external modifications in line are in evidence, particularly around the nose. The forward sloping V-type windshield has been retained, but the roof over the pilot's head has been rounded off a little more in the interest of reduced drag and greater cockpit space. In structure, however, the new fuselage is of the same type as the old. It is a true monocoque without longitudinal stringers made up of a series of overlapping flat sheets whose long dimensions run traverse to the longitudinal axis. Each panel is laid over transverse U-section diaphragms, lapping over the panel immediately behind it. Inasmuch as the panels are relatively short in proportion to the total length of the fuselage, it is not necessary to preform them, making for ease in manufacture, and, more important, for simple and inexpensive maintenance in the field.

The cantilever wing is set into the fuselage so that the bottom surface is tangent to the fuselage. The wing is in three parts, a center section which supports the landing gear and gasoline tanks and two outer panels bolted to the center section. The outboard wing panels are of the shell type. The main member comprises a corrugated upper and lower covering separated by a girder type front spar and a corrugated web type rear spar. Smooth Alclad is riveted over the corrugated inner sheets. The entire wing is rendered accessible for inspection by the removal of the leading edge sections which are built as units and attached to the front spar.

The tail surfaces, like the wing, are of the shell type of construction. Both fin and stabilizer are built integral with the fuselage. The small flap in the trailing edge of the rudder (adjustable on the ground only) takes care of any necessary trimming in yaw, and trailing edge tabs in the elevator, controlled from a handwheel in the cockpit, provide the necessary longitudinal trim.



One of the Vultee V-1A transports recently delivered to American Airlines.



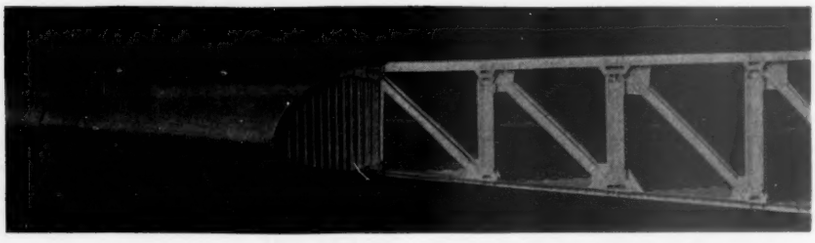
The landing gear is substantially the same design as in the earlier model. The main wheels are supported on single-box girder struts built up of duralumin. The upper end is fastened to a segment of worm wheel, and the lower end contains the shock absorber and the stub axles. To retract, the wheels are simply folded inboard into recesses in the under part of the center section. The regular retracting mechanism is electrically operated, but the usual auxiliary hand control is also available. The covers, which close over the wheel opening after the wheel has been retracted, have been redesigned, however, so that when the gear is in, the bottom surface of the wing is perfectly smooth without breaks or projections. The tail wheel is partially retractable and works automatically with the main gear. As in the first model also, landing lights are built into the wheel wells and are totally enclosed when the gear is retracted. Auxiliary wing-edge lights are also installed.

Split trailing edge flaps extend inboard from the aileron to well under the fuselage. The flaps are controlled by the same electric motor and auxiliary hand crank which operates the retracting gear. A small sliding gear transmission switches the drive from the flap to the landing wheels. Either the landing gear or the flap may be operated electrically, or by the auxiliary hand crank, or both can be operated together, one by the hand crank and the other by the electric motor. An indicator in the cockpit shows the position of the flap, and stop switches are provided to limit the motion up or down.

The power plant is Wright Cyclone Model F, developing 730 hp. The engine mount is assembled on accurate jigs and attached to fittings on the fire-wall by means of precision-ground bolts. All connections and controls are standardized, and are quickly detachable. It is thus possible to interchange engine mounts with any V-1A transport in a very short time.

The cockpit is regularly arranged for one pilot although there is space for two if desired. It is soundproof as well as the passenger cabin. Provision is made for direct-controlled radio in the cockpit, beside the pilot. The passenger cabin is arranged for eight people, with four chairs on each side of a 12-in. aisle. By means of sound insulation (Seapack) and noise filters in all ventilators and heater openings, the average noise level has been reduced to about 68 decibels.

With the Cyclone the ship shows a high speed of 235 m.p.h., cruises (75 per cent power) at 215, and lands with flaps down at 60. Climb at sea level is 1,000 ft. per min., absolute ceiling is 22,000 ft., service ceiling, 20,000 ft. General specifications show, length overall, 37 ft., height overall, 10 ft. 2 in.; span, 50 ft.; wing area (including ailerons), 384 sq.ft.; weight empty (arranged for one pilot only), 5,332 lb.; payload (eight passengers and 289 lb.



Wing construction is of the shell-type with detachable leading edge section.

of baggage and mail), 1,649 lb.; gross weight, 8,500 lb. The weight figures include complete Western Electric two-way radio, two (airway type) three-minute flares, and complete lavatory equipment. With 206 gal. of gasoline. the normal range is 1,000 miles.

The two-place, tandem, Flyabout.

American Eagle Flyabout

THE production of the new Flyabout by the Porterfield Aircraft Corporation, Kansas City, Mo., marks the reentry into the aircraft manufacturing and sales field of E. E. Porterfield, Jr., former president of the American Eagle Aircraft Corporation. The first plane was completed and test flown on July 4, 1934, nine years to the day after the start of his original venture, the Porterfield Flying Schools.

It is conventional in design and construction. Supervising designer was Noel R. Hockaday, who has spent the last ten years with Boeing, Laird, Wallace, and American Eagle. The Flyabout is a two-place, tandem, high wing monoplane with complete cabin enclosure. Its most unusual feature is in the ratio of power to weight, as compared with other light planes now on the market. The weight empty is 667 lb., and it is offered with a choice of two power plants, the LeBlond 60 or the LeBlond 70. The wings are conventional wood spar and rib construction with fabric covering. Span is 32 ft., total surface, 147 sq.ft. Overall length is 20 ft. 6 in. and height is 6 ft. 7 in. The fuselage and empenage structures are conventional chrome molybdenum welded steel tubes, fabric covered, and the undercarriage is provided with shock rings in the center and carries air wheel equipment with a tread of 66 in. Dual controls are standard equipment, with one set readily removable. The stabilizer adjustment is controlled by a cable running over pulleys and readily at hand in either cockpit. Gasoline capacity is 16 gal., giving a cruising range of 3½ hours, or 350 miles.

The Flyabout showed an indicated top speed of 115 m.p.h. on the first test flight. The plane is said to spin fast, come out readily, and to be very maneuverable, the test flight having included loops, rolls, spins, etc. Landing speed has been found to be approximately 40 miles per hour fully loaded with two people, 16 gal. of gasoline, and 25 lb. of luggage in compartment back of rear seat. To date the Flyabout has been flown to an altitude of 13,500 ft. with a pilot weighing 190 lb. and passenger of 225 lb., but without the altitude control hooked up to the Stromberg NAR-3 carburetor.

1,200-hp. Diesel

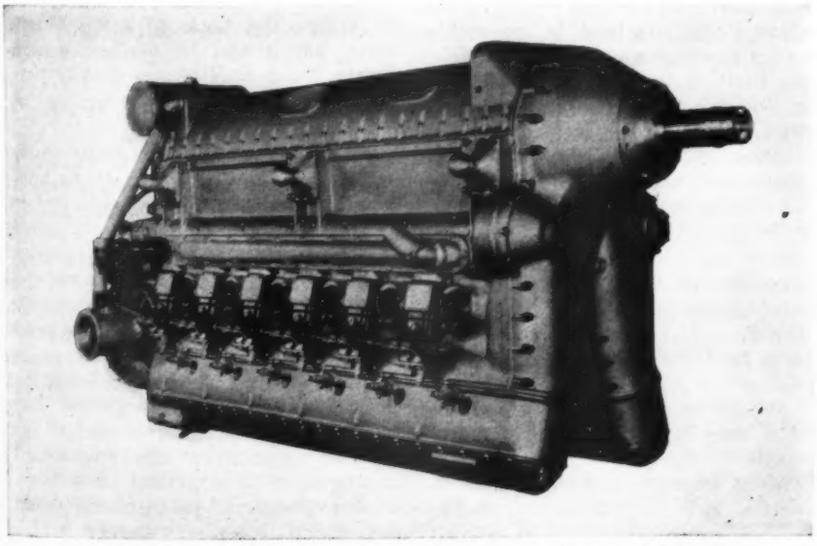
OVER three years of intensive research and development by D. J. Deschamps, at the plant of the Lambert Engine & Machine Company, Moline, Ill., has resulted in the building of a high horsepower two-cycle diesel engine for aircraft with many promising features. Unfortunately, due to the death of one of the principal financial backers, the final stages of development have been somewhat delayed. The possibility of 1,200 hp., with an all-up weight of 2,400 lb. behind a frontal area of only 1,314 sq.in. (about half that of a high-powered radial air-cooled engine) gives people who are thinking in terms of large aircraft in the immediate future something to ponder over.

The engine is an inverted V-type with two banks of six cylinders each operating at an angle of 30 deg. Bore and stroke are 6 in. and 9 in., respectively, giving about 254.3 cu.in. displacement per cylinder, or a total of slightly over 3,050 cu.in. for the entire engine. Its normal compression ratio is 16 to 1. The full specification calls for 28 Baumé oil.

One interesting feature is the reversability of the engine. It is designed so that it can run equally well in either direction, and the direction can be changed at will without making any structural changes. The reversible feature was incorporated primarily on account of lighter-than air requirements. It adds about 45 lb. to the total weight of the engine.

The Deschamps engine operates on a two-stroke cycle. It is of the fuel-injection type with two spray heads and two fuel pumps per cylinder. Fuel is injected on opposite sides of the cylinder tangentially to produce a whirling motion. Scavenging and supercharging air is delivered to the cylinders from two centrifugal compressors, one for each bank of cylinders. The impellers are driven at 13.5 times crankshaft speed and deliver a volume of air 125 per cent of the total engine displacement at about 12 lb. pressure at sea level. The air is introduced to each cylinder through two poppet valves in the heads. For starting or for idling purposes it is possible to decompress either one of the cylinder banks by holding the air valve open by displacing the camshaft axially. The cylinders exhaust through ports at the bottom into an exhaust collector that surrounds each bank.

It is usually difficult to operate a diesel engine at idling speed without cutting out a number of the cylinders completely by shutting off the fuel supply. This results in uneven operation, excessive vibration and a cooling off of the cylinders which are out of operation, which may prevent the engine taking hold immediately when full power is required. These difficulties have been avoided in the Deschamps diesel by cutting off the power from all cylinders on every other stroke, so that while all cylinders fire in regular order, they do



The Deschamps 1,200-hp. diesel engine has remarkably low frontal area.

so at half their normal rate. All cylinders are thus kept at uniform temperature and vibration conditions throughout the engine remain normal.

For starting purposes compressed air is used, manifolded to the cylinders of the lefthand bank only, the righthand bank usually being decompressed during starting. Air is supplied from a two-stage Heywood compressor and a storage tank provided with an automatic relief valve which maintains the pressure at the desired level. For cold weather, glow plugs have been provided in one bank of cylinders, but they are not used under ordinary conditions.

Cylinder blocks in the crank case are made of a single casting to save weight and to provide a rigid engine. The cylinders are provided with liners of Nitroloy steel. The liners are of the so-called wet type and provided with suitable gaskets to prevent leakage of Prestone or other coolants. Cylinder heads are of aluminum alloy cast in a single unit for six cylinders. A large number of heat-treated magnesium alloy castings are also used. Aluminum pistons are employed. Cooling system, the fuel system, the lubricating and scavenging system are separate for each bank of six cylinders, so the design is in reality a double six-cylinder engine.

Considerable interest has been indicated in the behavior of the Deschamps diesel from many sources, including both lighter and heavier than air designers. It is to be hoped that the work can be carried forward to its logical conclusion and some real performance figures obtained from flight tests.

NEW VOLUMES FOR THE SHELVES

BIBLIOGRAPHY ON SKIN FRICTION AND BOUNDARY FLOW, *by A. F. Zahm and C. A. Ross; Library of Congress; Washington, 1934; 46 pages.*

OF THIS nothing can be said except that it exists and that the source from which it comes is a sufficient guarantee of its quality. Students of aerodynamics, whether experimental or mathematical, will want to have it available as a reference. To no one outside their number would it be of the slightest possible interest. Dr. Zahm's own work on skin friction, started more than 30 years ago, is of course a classic.

AN INTRODUCTION TO AERONAUTICAL ENGINEERING *(Vol. II: Structure), by J. D. Haddon; Pitman Publishing Corporation, New York; 1933; 125 pages; $1.75.*

AN INTRODUCTION TO AERONAUTICAL ENGINEERING *(Vol. III: Properties and Strength of Materials), by J. D. Haddon; Pitman Publishing Corporation, New York; 174 pages; $2.50.*

MR. HADDON has a rather remarkable gift for condensation, and he has shown it to full advantage in covering the whole subject of airplane structural analysis and detail design of parts in 125 small pages. Everything that is in his book has been said before, but seldom has it been said so well in so few words. For American readers, however, there is a serious handicap in that the point of view is wholly British and all the references are to British publications, load factor rules, material, specifications, and so on.

Despite that drawback the books may find a use, for we know nothing written from an American background that so successfully fills the bill for the draftsman with no knowledge of higher mathematics who wants to extend his appreciation of aeronautical engineering.

JUNKERS UND DIE WELTLUFTFAHRT, *by Capt. Fischer von Poturzyn; Richard Pflaum-Verlag; Munich, 1934; 183 pages; $1.50 approximately.*

INTERESTING for its own sake to those who read German readily, Captain von Poturzyn's book is interesting also even to those whom linguistic difficulties limit to looking at the pictures as an evidence of the really phenomenal extent of modern Germany's air-mindedness and of the ways in which it is being cultivated. Here is the story of the Junkers company in aviation, from the wartime down to date.

SURVEY OF THE AIR CURRENTS IN THE BAY OF GIBRALTAR, *by J. H. Field and R. Warden; H. M. Stationery Office, London, 1933; 60 pages; $1.35 approximately.*

THIS may not sound like an aeronautical subject, but it describes a research of immense aeronautical interest. As a result of unexplained crashes and difficulties in the control of aircraft around the Rock of Gibraltar, a program of study was initiated that included both full-scale mapping of air currents with pilot balloons and testing of a scale model of the Rock in a wind tunnel. The results can hardly be abstracted in a paragraph, but they showed a surprising degree of variability in wind direction and force within relatively short distances around the Rock, an immense amount of turbulence and a definite periodicity of behavior on the lee side, and deviations of wind direction from the horizontal of as much as 35 deg.

RECOLLECTIONS OF AN AIRMAN, *by Col. L. A. Strange; John Hamilton, Ltd.; London, 1933; 224 pages, $3, approximately.*

ANOTHER tale of the war in the air, this one with the Royal Air Force as a background. Colonel Strange learned to fly in 1913 and celebrated the transition from peace to war by competing in the British Aerial Derby in the summer of 1914. He went through four years of the war without disaster, and then turned to the sale of commercial airplanes. His story of the old days before the war and of battles over northern France is good straightforward narrative, but it has a little too much of the air of a diary and is too full of names and places to be easy reading.

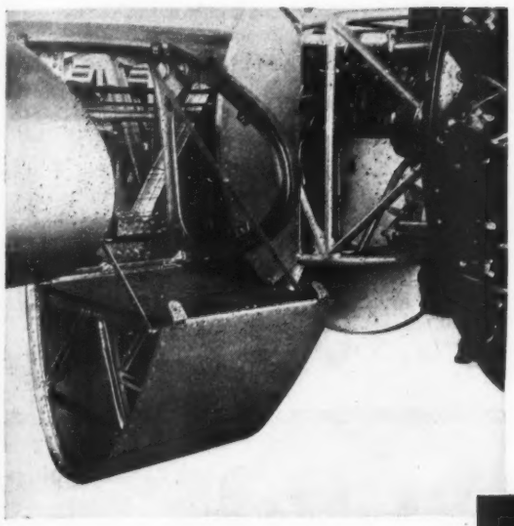
BY AIR, *by Sir Harry Brittain; Hutchinson & Company; London, 1933; 288 pages; $3.25, approximately.*

SIR HARRY BRITTAIN is one of England's most enthusiastic patrons of air transport, and he seems also to be one of Great Britain's most unremitting collectors of anecdotes. The tale of British aviation that he has told here is a succession of stories of individual experiences and amusing happenings, lightly strung together on a thread of continuity. It is impossible to assign the book to any particular class, but it can be marked down as pretty good reading, especially in its most anecdotal sections.

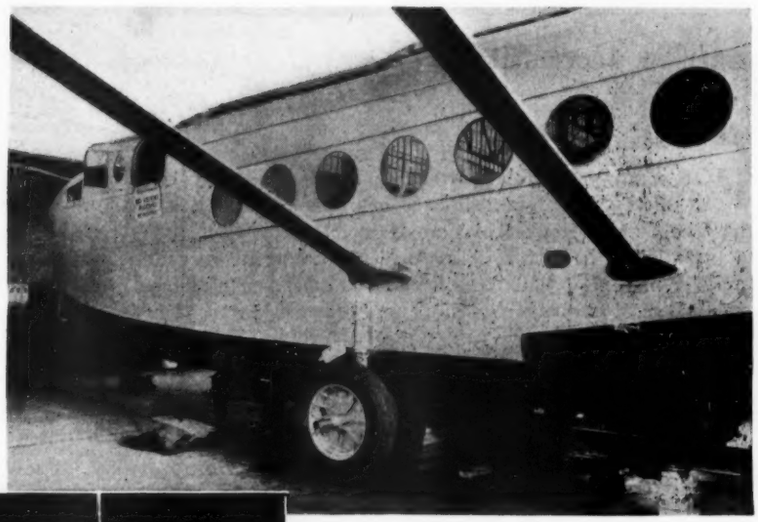
THE STORY OF AIRCRAFT, *by Chelsea Fraser; Thomas Y. Crowell Company; New York, 1933; 510 pages; $2.50.*

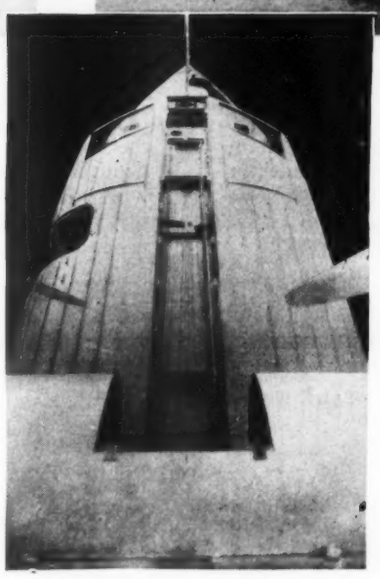
MR. FRASER has had a world of practice in the writing of boys' books of science, and his experience shows to good advantage in the present volume. Telling the story of aviation from the earliest beginnings down to the present day, it achieves a very happy blend of scientific and historical accuracy with excitement and romance. The arrangement is excellent, and the reviewer discovered no technical error of even the slightest importance.

SERVICING SHORT CUTS



Section of leading edge furnishes a working platform for engine servicing.





Port side beaching gear in place. The wheels may be 360-deg. swivelled to permit sideways movement of the ship. Left: All engine controls from cockpit may be reached by removing panels on forward deck.

S-42, Designed for Maintenance

ECONOMICALLY maintained airplanes don't just happen. Features that make for good servicing must be designed into them from the beginning and are nowadays recognized as of almost equal importance as performance and passenger comfort. In the Brazilian Clipper S-42, Pan American Airways wrote into its maintenance specifications literally hundreds of suggestions from pilots, division engineers, beaching crews, servicing and overhaul personnel. Space limitations prevent mention of but a few of unusual interest.

The difficulties of beaching flying boats increase rapidly with their size. A simple and effective gear has been developed that makes it possible to get the S-42 in and out of the water in an incredibly short time. Large, double pneumatic tired wheels attached to tubular struts may be floated out and quickly attached to the forward lift strut fittings on each side of the hull. Removable plates cover the attachment points when they are not in use. Wide-bearinged, open-ended forks in the upper end of the wheel struts slip under pins set into the hull fittings. The wheels are forced in a downward arc until the struts parallel the hull sides, and are locked in place by a pair of vertical pins which engage in eyes fastened to the chines. The tail wheel (also pneumatic) is carried in a forked bracket that slips easily into sockets on the stern-post. Two or three men can readily prepare the ship for beaching in three or four minutes.

Where engines are as far from the ground as those of the S-42 it becomes a real problem to reach them conveniently for servicing. Large scaffoldings are impractical, except at main bases. By making sections of the leading edge on both sides of each nacelle hinged so that they may be unlatched and swung downward, very practical servicing platforms have been made available at all times. From the steps (which are surfaced with a non-skid material) mechanics may easily reach each engine and its accessories on each side. Flush type cowl fasteners retain the leading edge sections in normal flying position. Walkways along the top surface of the wing give access to the platforms, gasoline and oil filler caps, lights, etc.

Both top and bottom wing surfaces are provided with large removable inspection panels to give full access to the interior. The whole section over each fuel and oil tank may be lifted off as a unit, completely exposing all piping and valves. Such tank covers are reinforced to form parts of the wing walkway system.

In the hull the transverse framing has been so spaced that a man may go down through removable floor sections and have ample room between them for inspection and repair. The attachment of the bottom plating is such that there are no pockets to retain bilge water. All water between water-tight bulkheads drains through drain plugs at the lowest point.

All controls run through ducts from which the covers may be removed to permit inspection through the entire length. Electric wiring all runs through aluminum conduit. Batteries fit into drawer-like compartments opening directly into the forward companionway. The rear of all instrument boards may be reached through removable panels behind them. Stabilizer adjusting mechanism and the anchor operating winch are both open for inspection and maintenance from the after and bow compartments respectively. These and dozens of other items like them should make S-42 one of the most readily serviced ships in existence.

THE BUYERS' LOG BOOK

AVIATION'S *Card Index of New Equipment*

This department is equipped to help readers locate manufacturers of any parts, accessories or materials

AIRPLANE ACCESSORIES — **Catalog**

Karl Ort,
611 West Poplar St., York, Pa.

FOR many years Karl Ort has specialized in supplying all sorts of aeronautical equipment and accessories to the trade. His latest Aviation Materials Catalog (1934) is just off the press and is available at a cost of 10 cents to cover mailing. This edition includes his latest prices on new and used engines, propellers, instruments, parts, etc.

AVIATION, *August, 1934*

INSTRUMENTS — **Electric tachometer**

Pioneer Instrument Company,
745 Lexington Ave., Brooklyn, N. Y.

TYPE 840 Tachometer combines accurate r.p.m. indication and precise synchronization on multi-engined planes. Each unit consists of a small two-phase, three-wire, A.C. generator mounted on engine and an indicator of the induction disk type on instrument board. Wide scale readings, 0-3,000 r.p.m. Temperature compensated. Synchronizer (extra) operates from tachometer generators.

AVIATION, *August, 1934*

LABORATORY EQUIPMENT — **Oil tester**

Lub-o-Meter, Inc.
111 West Washington St., Chicago, Ill.

A DEVICE to test the lubricating qualities of engine oils (new, or from crankcase) has been developed. The Lub-o-Meter tests the cohesion properties of oils by indicating the time required to break a film of standard thickness at crankcase temperatures. Indicates when oil changes should be made, or what grades of oils should be added for make-up. Literature available.

AVIATION, *August, 1934*

RADIO — **Aviation receiver**

RCA Victor Company, Inc.,
Camden, N. J.

TO REPLACE the earlier model AVR-5 the model AVR-5 has been announced as a general purpose receiver covering frequencies from 150 to 18000 kc. Superheterodyne circuit employs nine tubes. Operates from 110 or 220 volts, 50/60-cycle AC power supply. Headphone or speaker reception. Constructed to withstand tropical climates. $22\frac{1}{8} \times 13\frac{9}{16} \times 10\frac{17}{32}$ in.

AVIATION, *August, 1934*

PARTS — **Instrument mounting nuts**

A.G.A. Company, Elastic Stop Nut Division,
Elizabeth, N. J.

THE line of Elastic Stop Nuts has been augmented by a special device to simplify aircraft instrument maintenance by making units quickly detachable from board. Vibration-proof, applicable to standard cases. Available in several materials for 6-32, 8-32, 10-32 tap sizes, in various types to suit specific instruments. Dimension sheet (A-100) available on request.

AVIATION, *August, 1934*

PARTS — **Aircraft stampings**

Wrought Washer Manufacturing Company,
2100 South Bay Street, Milwaukee, Wis.

THIS concern, longtime suppliers of washers and miscellaneous parts to the aviation trade, has announced the availability of its tool and die departments for the manufacture of metal stampings for aircraft. Not only will parts be stamped to order, but complete tool and die service will be offered to manufacturers who plan to produce their own parts.

AVIATION, *August, 1934*

PARTS — **Roller bearings**

The Bantam Ball Bearing Company,
South Bend, Ind.

A SERIES of quill, or needle type roller bearings has been developed for application to landing gear control, flap and other control surface hinges for aircraft. Such bearings are very compact, easily maintained, and are capable of handling relatively heavy loads. A number of them were used on board the latest Vultee transports built for American Airlines (see page 270), this issue.

AVIATION, *August, 1934*

SHOP EQUIPMENT — **Spray gun**

H.D.B. Corporation,
900 N. Spaulding Ave., Chicago, Ill.

TO MEET the need for a type of spraying equipment to handle the newer finishing materials satisfactorily, H. D. Binks has designed the No. 5 Spray Gun. Has a revised nozzle head which atomizes heavier materials completely at reduced spray speeds, a feature which cuts down waste and eliminates orange-peel effects. Descriptive literature on request.

AVIATION, *August, 1934*